WORKING PAPER NO. 78-1

DRILLING AND FIELD CONSTRUCTION COSTS IN THE CANADIAN PETROLEUM INDUSTRY

GORDON M. ENGBLOOM
CONFER CONSULTING LTD.

JANUARY, 1978

Working papers are distributed by the Canadian Energy Research Institute in limited numbers. They represent the results of work in progress and are made available in this preliminary form both for information and to obtain comments.

CONTENTS

Chapter 1	Introduction and Conclusions	1
Chapter 2	Relevant Economic Factors	11
Chapter 3	Drilling Costs	22
Chapter 4	Field Construction	58
Appendix A		73
Appendix B		75
Appendix C		80
Appendix D		82

CHAPTER 1

INTRODUCTION AND CONCLUSIONS

1.1 Introduction

The purpose of this study is to analyze the cost experience of drilling and field construction in the petroleum industry in Alberta and frontier regions over the 1973-76 period, with a view to identifying the factors that would improve the basis for projecting these costs over the next five to ten years.

The approach taken in the study is to commence by analyzing the general economic performance of the world's industrialized countries. This analysis, which pays particular attention to the United States and Canadian steel market and the Canadian labor market, serves to identify the principal factors involved in the general price behaviour of the major basic inputs into the drilling and field construction industries.

With this background, each of the industries studied is analyzed to determine the specific factors which caused the cost increases over the review period. These factors are then examined to determine which are relevant to future cost behaviour in each industry.

For the purposes of this study, it is necessary to define the activities studied in the drilling and field construction industries. In the drilling industry, the increases in costs incurred by the drilling contractor for equipment, materials, labor and camp expenses, and the effects of the demand for drilling, location, seasonality, depth of drilling and government requirements are examined. The expenses studied in the field construction industry centred on those associated with gathering line construction and including pipe, coating, valves and fittings, line installation, tie-ins, survey, easements, supervision and miscellaneous other expenses.

Wherever practical, the analysis of drilling and gathering system construction costs is expanded to indicate the cost experience of the more general exploration, development and field construction costs. For perspective, using 1976 data, the expenditure in Canada on exploratory and development drilling was $903 million. Geological and geophysical expenditures amounted to $274 million and land and lease acquisition amounted to $334 million. Also in 1976, the construction of gathering systems accounted for about 40 percent of the total number of miles of pipeline constructed, but proportionately less than the total expenditure of $64 million[1].

---

[1] Source: Canadian Petroleum Association Statistical Handbook.

1.2 Conclusions

1.2.1 The 1973-76 Cost Experience

The principal source of cost increases in the drilling and field construction industries was the significant price level increases which occurred in industrialized economies. Price level increases during the first half of the review period were due to a concurrent economic boom in almost all industrialized nations which was compounded by key supply constrictions, particularly in the commodity sector. The price level increases during the latter half of the period were due to the labor and manufacturing sectors catching up with, and protecting themselves from, inflation.

The price of raw steel at the mill, which is a major basic input into both industries studied, rose by some 50 percent over the review period. As was the case with the general price levels, the steel prices rose due to excess demand during the first half of the review period and cost-push during the last half.

The cost of labor in the Canadian ecomomy did not accelerate significantly until 1974 when it began to respond to eroded real returns. However, because the gain in labor rates was especially great during the 1975 recessionary period, these wage gains became a part of the cost-push price increases.

In the drilling industry, various influences over the review period resulted in a net increase of 60 to 70 percent in the cost of drilling a typical well south of 60^{o} N. The cost increases for several items such as the drilling contractor

charges, which include drill pipe and collars, also increased by some 60-70 percent due to actual cost increases of about 100 percent being tempered by greater rig utilization which allowed fixed costs to be spread over a longer period of time. However, many cost increases for items such as casing, tubing, well heads, cementing and the like were not tempered and flowed directly through the various contractors and suppliers to the operators.

There was an upswing in the demand for drilling in the United States and Canada commencing in 1972. It was further boosted by the large crude oil price increases of 1973 and thereafter, and by a new sense of urgency to find new energy sources. The crude oil price rise and the new sense of urgency were world-wide factors in the demand for drilling, and the quickness of this demand development resulted in very heavy drilling equipment demands over the review period. The equipment demands were particularly heavy during the 1973-74 period when a large number of new offshore rigs were constructed. These factors in the world-wide drilling industry were the second largest cause of increases in drilling costs.

The heavy demands to supply equipment to the drilling industry coincided with the concurrent world economic boom, and this resulted in extra demand pressure being put upon basic inputs such as steel products. The increased pressure on demand resulted in increased prices because constraints produced bottlenecks in the supply of several types of equipment and materials. As well, the previously attractive price of good used drilling equipment

relative to new equipment altered dramatically, resulting in an increase of some five to seven fold in the price of used drilling equipment over the review period.

The demand to develop new energy sources resulted in continued frontier drilling over the review period. The costs of frontier drilling are on a completely different plane than the costs of drilling in traditional areas. The need to have good equipment complete with back-up systems to avoid down time combines with very high transportation costs to make land based frontier drilling expensive. Further, the same considerations are combined with the need to have supporting structures for offshore drilling to make it even more expensive. The resulting very high fixed costs associated with frontier drilling can only be economically rationalized by spreading the costs over a multi-well drilling program, and these programs require long periods of stability in the parameters which influence risk and return on investment.

While the demand for drilling equipment and supplies was high over the review period, the slackening in world economies over the last half of the period resulted in increased supply availability of equipment, but prices continued to rise for most items, although at reduced rates.

The third most significant source of cost increases in the drilling industry over the review period was due to either the lack of or severity of government actions within Canada. The dispute between levels of government over the price and disposition of

revenue from crude oil and, to a lesser extent, natural gas, resulted in dislocation costs which were significant. Some of these costs still linger in certain areas of the drilling industry where the supply and demand for drilling rigs continues to be out of balance. In addition to the dislocation costs, there were areas of uncertainty with respect to jurisdictional and land regulations which have prevailed and resulted in increased costs.

Finally, drilling costs were also influenced by two offsetting factors whose net effect is difficult to quantify. The increased use of the tungsten carbide insert, sealed bearing bit resulted in working and cost reducing efficiencies. However, these were offset by greater drilling quality control demanded by the operators.

In the gathering system construction business, the average increase in overall costs between 1973 and 1976 was some 60 percent. Steel pipe costs which form the largest cost factor, increased by some 57 percent at the mill, but increased transportation costs resulted in a cost increase of 73 percent for delivered steel pipe.

The costs of labor in the gathering system construction business increased about 55-60 percent which reflects labor costs based upon the general trend in overall wage levels and not upon the higher wage levels of a specific industry, such as unionized construction. It should be noted that the costs of labor for gathering system construction reflect a non-union, largely low-skilled and transitory work force.

The cost of easements increased at a rate above the 60 percent average cost increase due to considerable pressure on land prices over the period.

The expanding use of the "Zap-Lok" cold-joining process for pipe connections, particularly in the low pressure gas area of southeastern Alberta caused a cost reduction due to fewer skilled members on the construction crew, and an increased pace of pipe connection.

The continued improvements in planning and substitution of shop fabrication for field fabrication combined with a trend toward constructing larger gathering systems under one contract to reduce costs increases. But, difficulties in getting pipeline permit approvals, and increased environmental and archeological standards resulted in offsetting cost increases. Again, it is difficult to quantify the net result of these offsetting effects.

1.2.2 Factors in the Behaviour of Future Costs

For both the drilling and field construction industries, the overall ecomomic performance of the industrialized world will be crucial to the costs which occur in these industries. There will be continued periods of strong economic activity due to business cycles and government stimulus, and these will cause price movements in basic inputs such as steel and labor which will find their way to the industries' costs.

The probability of a new concurrent world economic boom is not clear. Certain indicators may be used, however, to give perspective to world economic conditions. Such indicators would include a price index for raw commodities, the level of industrial production in the United States, Canada and other OECD countries, the GNP price deflator of several major economies, the real wages of the industrial composite and of the construction and petroleum contract drilling sector, and major structural changes in the supply of basic goods and services.

The price of steel inputs into both industries appears to move with demand during periods of high capacity utilization, and with costs during periods of low utilization, although steel industry profits seem to fluctuate with demand.

In the drilling industry, the costs to drill a typical well will increase at a rate greater than the prevailing inflation in economy. This will be due to continued world-wide demand for drilling equipment, and new standards applied by the government. However, the low probability of a price increase for crude oil of the magnitude and quickness of the 1973 increase, combined with fewer constrictions in the supply of drilling equipment will keep cost increases below those which prevailed in the review period.

In Canada, and particularly Alberta, there will be cost increases due to the indroduction of government regulations respecting well control, vehicle road weights, and possibly improvements in working conditions. However, most of these cost increases

will be discrete in nature; that is, they will affect cost increases in a step-wise manner, but, once in place, they will not have a continuing effect upon the rate of cost increases.

There will be a continuation of the trend towards requiring manpower which is skilled in drilling procedures and methods. This will result in labor costs increasing not only to keep up with the wages of industries competing for labor, but also to remunerate the manpower in accordance with improved skills. The increased labor costs due to improved labor skills will occur over a longer term, and the pace will be determined by a number of factors such as the overall demand for drilling, the demand for drilling deep and frontier wells which are more difficult than wells in traditional areas, the ability of the contractors and operators to measure the benefits of skilled labor, the regulations of the government with respect to well control and safety, and, finally, the ability and willingness of the operators to pay for improved labor skills and efficiency.

In field construction, the future cost increases should be close to the overall rate of inflation in the basic inputs such as steel, labor, and construction machinery. The prices of these inputs will vary with the general economic situation, and, to some extent, with the price movements in the construction sector of the economy.

However, because there are few bottlenecks in the supply of steel pipe and low-skilled labor, it is not probable that price increases will exceed the average rate of increases in

these sectors. For steel pipe, the ability of imported pipe to compete in North America adds to the supply channels available, and only another concurrent economic boom amongst world steel producers would cause major supply constraints. For labor, there will be little need to have more skilled manpower employed by the contractor, and, indeed, where the cold-joining process can be used, less skilled manpower will be required. Thus there will be no cost increases due to upgrading skills, but only those needed to attract people to work.

A continuation of more and better planning, and more shop fabrication will result in cost efficiencies, and these will be greater as the use of the cold-joining process becomes more widespread. As well, the trend to build large gathering systems under one contract allows cost efficiencies to be introduced in terms of transportation, and assembling material, equipment and crews, and this trend will continue wherever possible.

The bottleneck between the government and owner over permit approval will be resolved so as to leave a well-defined lead time for permit application and this will improve planning. The new government vehicle weight regulations will cause a discrete increase in the rate of cost increase which will occur over the next one to two years.

CHAPTER 2

RELEVANT ECONOMIC FACTORS

The most significant cause of rising costs in the drilling and field construction industries was the world economic situation which raised the price of labor and primary manufacured goods. Both industries studied have virtually no control over the aggregate price and supply of these inputs, and, because the industries directly pass through their cost increases, it is important to examine the economic situation.

2.1 World and North American Economic Performance, 1973-76

During 1973 and early 1974, the world experienced, for the first time, a concurrent boom in economic activity within virtually all industrialized economies. Previous to this concurrent boom, industrialized economies had experienced booms which were out-of-phase with each other, and this allowed excess capacity in a slack economy to service the tight supply in the booming economy. However, the concurrent boom precluded such trade, and the result could only be price rises to produce a balance between supply and demand.

In addition, the supply of many inputs into the economies was affected by new structural arrangements, as in the case of crude oil, and by bottlenecks, both of which acted to further

increase the price rises resulting from the demands of the concurrent boom.

A sectoral review of the price rises during the review period shows that commodity prices, as measured by the United States Bureau of Labor Statistics (BLS) 22 commodity index, commenced a sharp rise in 1972. These prices increased 85 percent over the next two years before dropping by 14 percent in 1975 when a near-concurrent recession, which commenced in the last half of 1974, was most severe. However, the commodities returned to an upward price path in 1976, ending that year at a level within 5 percent of the 1974 peak[1].

While the recession during the latter part of 1974 and through 1975 caused the commodity prices to drop, it did not have the same effect upon labor and finished or fully manufactured goods as is made clear in Chart 2-1. During the 1975-76 period, when demand and capacity utilization were at reduced levels, the prices of labor and fully manufactured goods rose significantly, and both of these inputs are heavily relied upon by the drilling and field construction industries[2].

Price increases occurring during a period of falling or weak demand contradict a basic economic property of markets.

---

[1] A breakdown of price trends amongst the components of the BLS 22 index is given in Appendix A, Table A.1.

[2] For a full examination of capacity utilization in Canada, see the June, 1977, Bank of Canada Review, pages 3-9.

CHART 2-1

GENERAL ECONOMIC ENVIRONMENT

YEAR	(1) OECD INDUST. PROD. INDEX	(2) U.S. INDUST. PROD. INDEX	(3) CAN. INDUST. PROD. INDEX	(4) U.S. BLS 22 COMMODITY INDEX	(5) U.S. WPI FINISH GOODS	(6) CAN.WPI FULLY MANUF. GOODS	(7) U.S. GNP PRICE DEFLATOR INDEX	(8) CAN.GNP PRICE DEFLATOR INDEX	(9) U.S. MANUF. WAGE COST PER OUTPUT INDEX	(10) CAN. MANUF. WAGE COST PER OUTPUT INDEX
1970	100	100	100	100	100		100	100	100	100
1971	102	102	106	95.2	102.9	100	105.1	103.2	101	102
1972	109	111	113	105.2	106.3	107.3	109.5	108.4	103	106
1973	119	120	122	150.8	116.0	123.5	115.8	118.4	107	111
1974	120	120	127	195.0	133.7	147.9	127.4	135.3	113	122
1975	110	109	121	167.2	148.1	162.9	129.3	149.8	121	139
1976	120[a]	121[a]	127[a]	185.7	153.5	172.1	146(e)	164.1	124[a]	154[a]

SOURCE: Statistics Canada; National Institute of Economic and Social Research, London, England; Statistical Abstract of the United States, Department of Commerce, Bureau of Census, 1976.

[a]Implies Third Quarter, 1976 figures

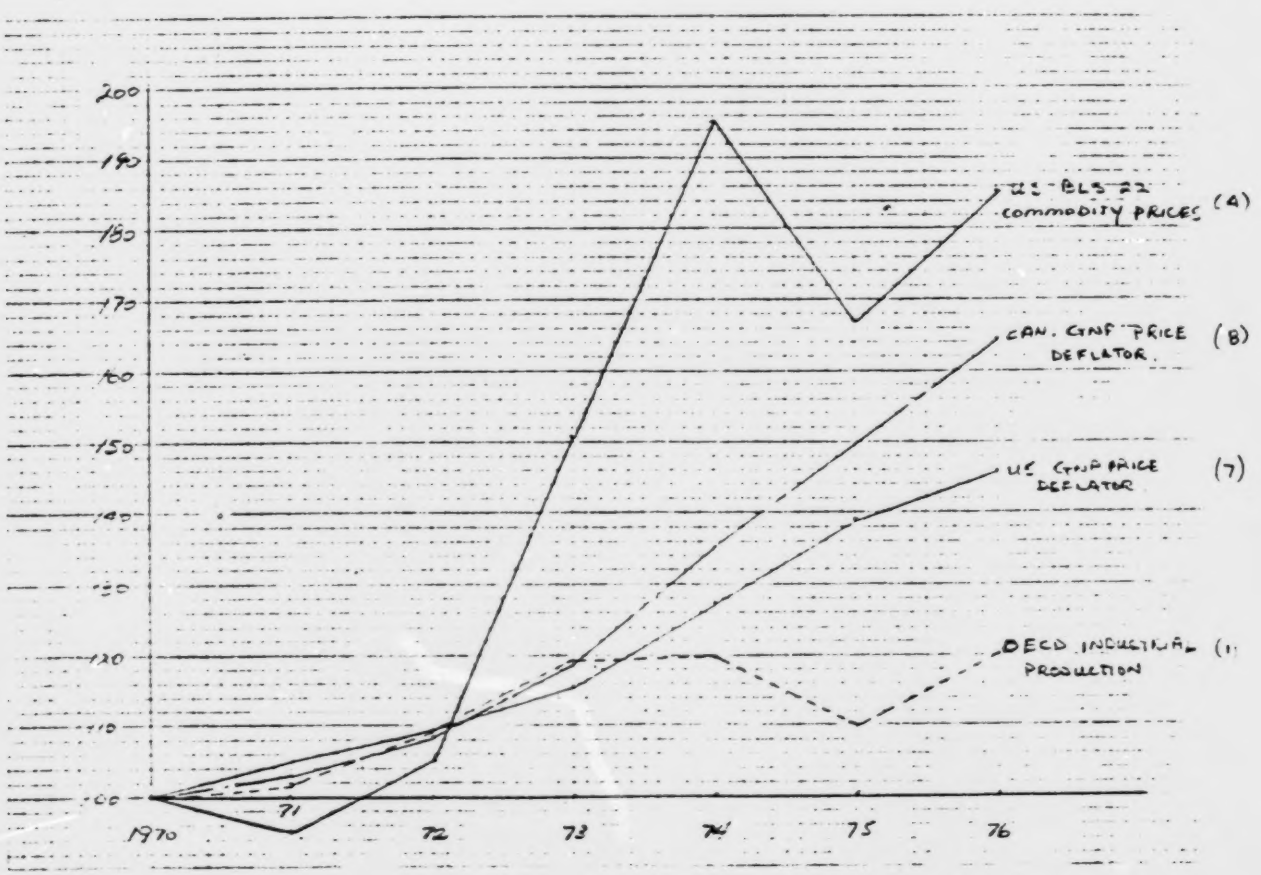
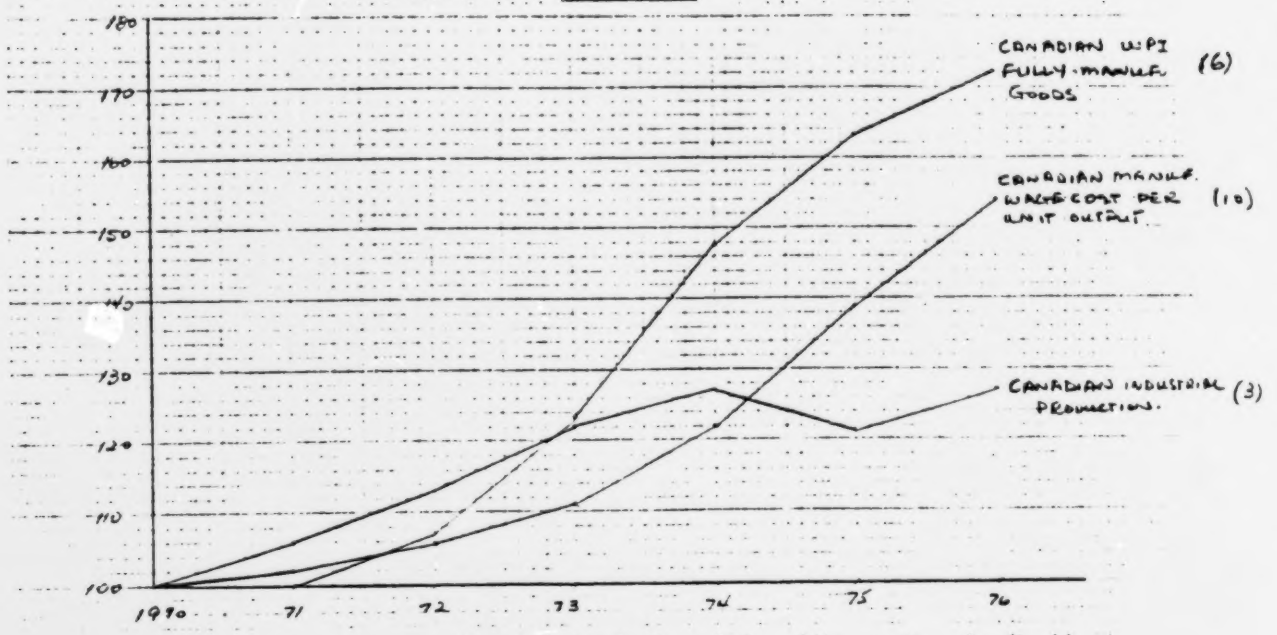
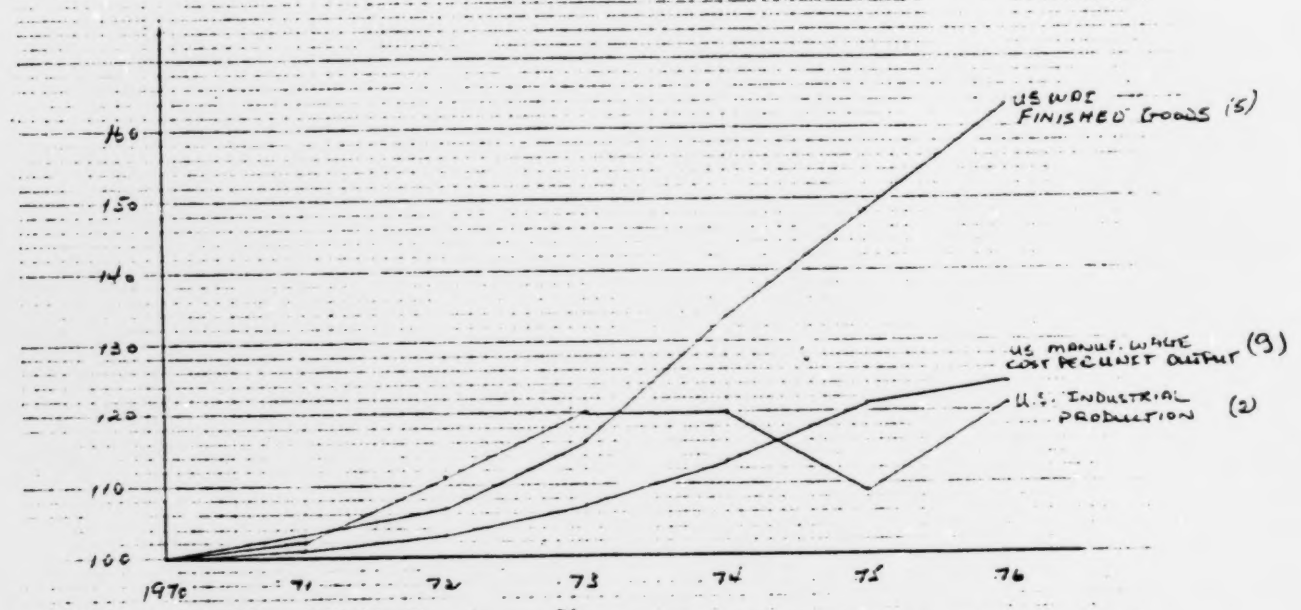


CHART 2-1 - CONTINUED





However, as indicated above and in what follows, there are situations where

> Industrial prices (in contrast to the prices of primary products) are not 'market clearing'...Such 'administered prices' are cost-determined, not 'market determined'; they are arrived at by applying various percentage additions to direct labor and material costs on account of overheads and profits[1].

The drilling and field construction industries were subject to this form of pricing for their major inputs. To illustrate this, the steel and labor markets are briefly analyzed below.

2.2 Steel Markets

Steel is a major input into both industries studied, and many steel products for these industries come from the United States as well as Canada. Consequently, both steel markets must be studied.

The North American steel market is economically accessible to imports, which can, at times, be very competitively priced. This situation tends to limit the upward movement of prices whenever excess supply exists outside North America, although major buyers do pay a premium for domestically produced steel to ensure deliveries during periods of heavy demand.

With this background, the data found in Chart 2-2 confirms the fact that world steel demand peaked in the 1973-74 period,

---

[1] Nicholas Kaldor, "Inflation and Recession in the World Economy", The Economic Journal, 86 (Dec., 1976), 705.

CHART 2-2

STEEL

YEAR	(1) CAN. STEEL PIPE & TUBE MILL PROD. INDEX	(2) CAN. STEEL PIPE & TUBE MILL PRICE INDEX	(3) CAN. STEEL INDUSTRY R.O.E. (%)[a]	(4) CAN. GNP PRICE DEFLATOR INDEX	(5) U.S. STEEL MILL PROD. INDEX	(6) U.S. STEEL MILL PRODUCT PRICE INDEX	(7) U.S. STEEL INDUSTRY R.O.E. (%)[b]	(8) U.S. GNP PRICE DEFLATOR INDEX	(9) WORLD STEEL PROD. (TONS MM)
1971	100.0	100.0	9.3	100.0	100.0	100.0		100.0	639.9
1972	118.5	103.8	9.5	105.0	104.0	106.0	5.6	104.1	694.8
1973	123.4	113.5	11.7	114.7	119.5	109.0	9.1	110.2	768.6
1974	141.3	136.3	15.4	131.1	116.7	138.2	16.0	121.2	782.8
1975	142.1	162.0	10.8	145.2	86.8	160.2	9.5	130.8	716.2
1976	120.5	178.8	10.1	159.0	95.0 (e)	164.7	12.1	139.0 (e)	N.A

SOURCE: Statistics Canada; Business Week; Financial Post Cards; Statistical Abstract of the United States, Department of Commerce, Bureau of Census, 1976.

[a]These figures are derived from the aggregate of the Steel Company of Canada, Algoma Steel Company, and Dofasco Steel Company. R.O.E. = Return of Equity.

[b]These figures are industry-wide.

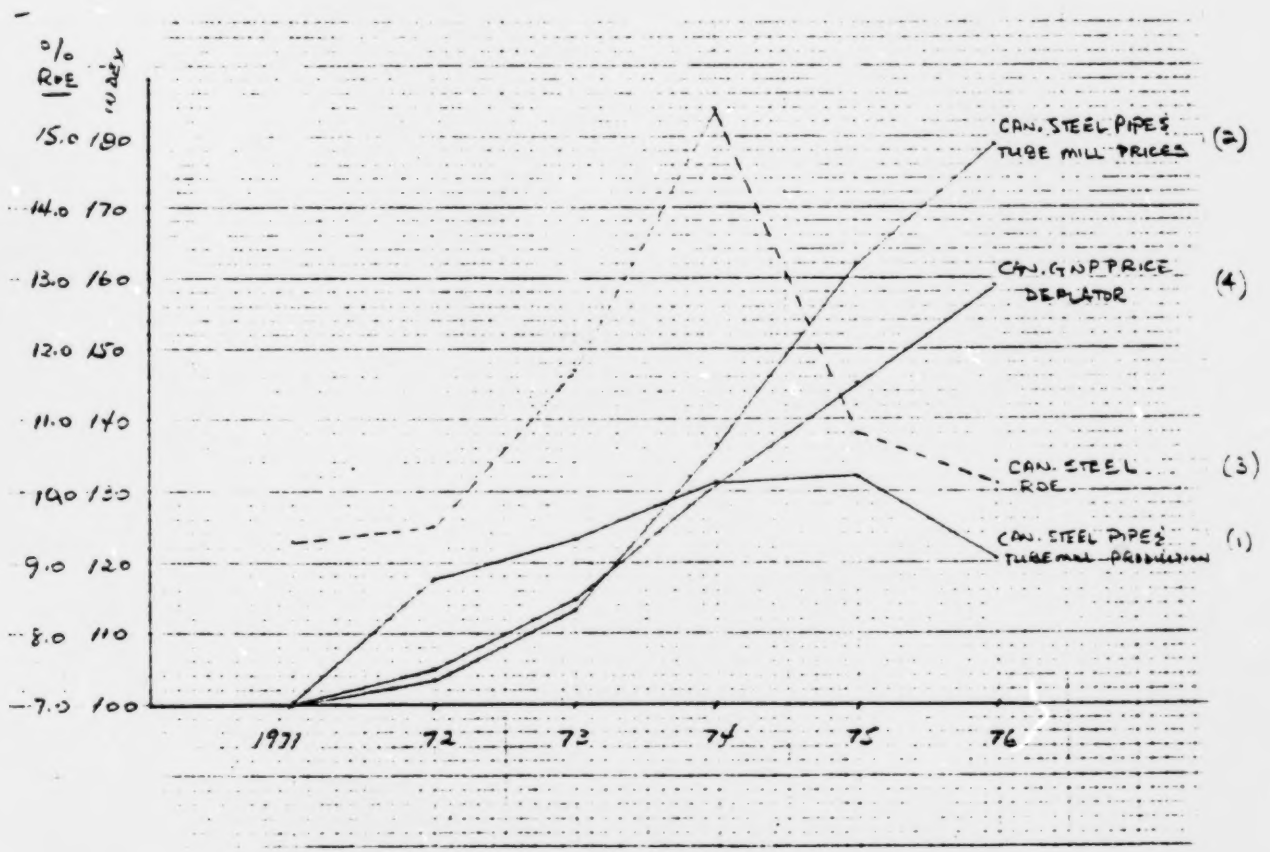
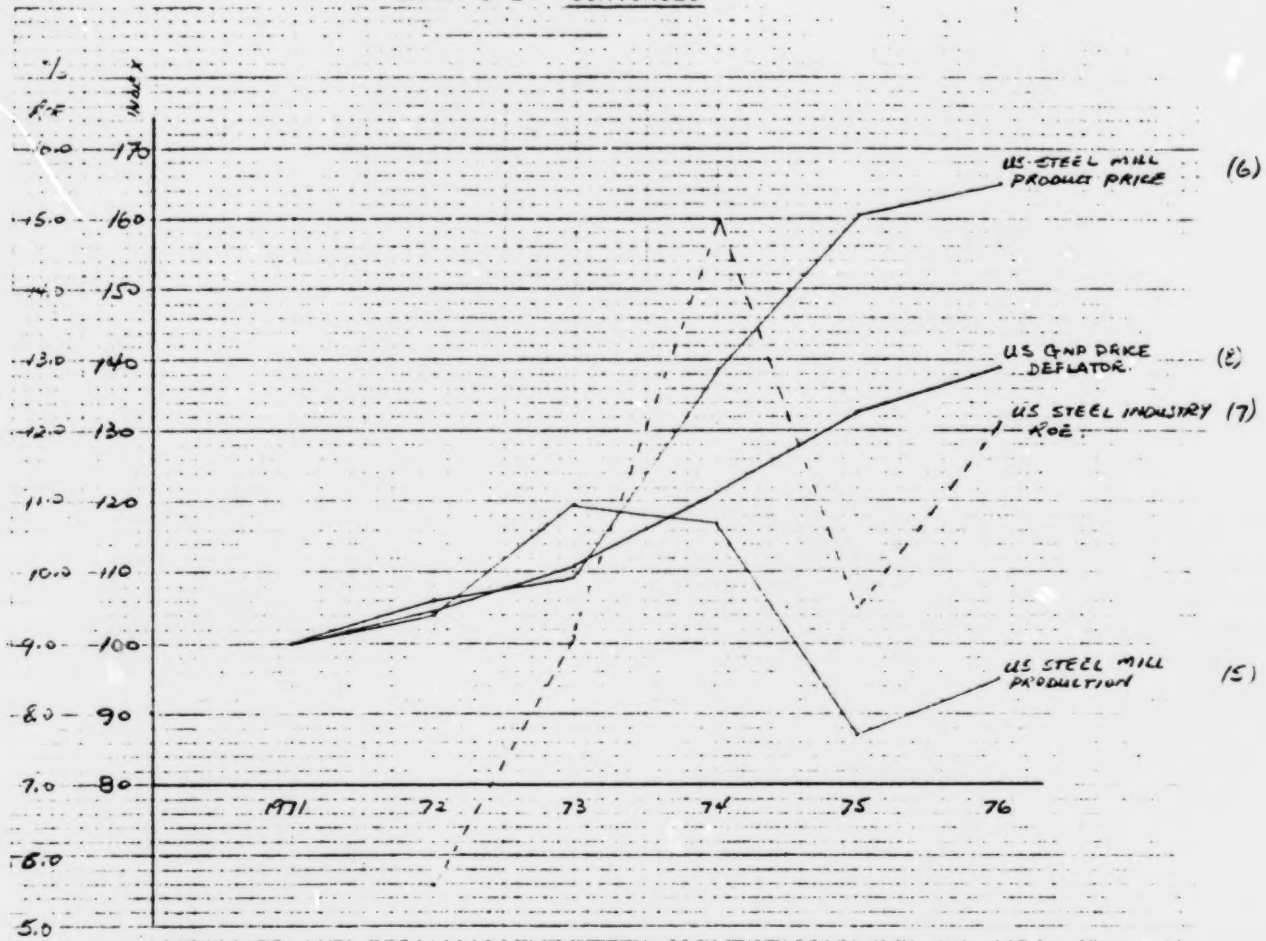


CHART 2-2 - CONTINUED



and that prices rose in response to demand, resulting in significant gains in the return on equity for the steel industry[1].

However, the downturn in demand brought on by depressed markets in 1975 and 1976 resulted in increased prices and a decreased return on equity. This was due to the cost-push of other sectors of the economy catching up and protecting previously eroded real returns.

It was further compounded by two other factors. First, when firms face reduced demand due to a recession, they must still pay fixed costs and they often retain skilled personnel, both of which tend to keep costs high. As a result, the costs per unit of output naturally tend to rise during periods of reduced demand. Second,

> When demand drops off, (steel) producers adjust their prices according to demand and cost factors, including the products' price elasticity of demand.[2]

That is, the steel industry uses cost factors as a parameter in its pricing decisions, and cost-push or fixed cost factors result in higher unit costs which are especially evident when demand is slack. These higher unit costs enter into the pricing and output decisions of the steel industry and clearly play a major role in explaining the steel price rises of the latter half of the review period.

---

[1] The figures used for the Canadian steel industry reflect the aggregate total of the Steel Company of Canada, Algoma Steel Company, and Dofasco Steel Company. The U.S. figures are industry wide.

[2] J.F. Weston and E.M. Rice, "Do Steel Producers Administer Prices?", Challenge, (Nov./Dec., 1976), 24.

In conclusion, the drilling and field construction industries, which are heavily dependent upon steel product inputs, were faced with the price of steel being demand sensitive during periods of high utilization of steel-making capacity, and cost sensitive during periods of reduced demand. As a result, steel prices at the mill rose some 50 percent over the review period.

2.3 Labor Markets

The direct cost of labor constitutes a relatively large part of the costs of the drilling and field construction industries. As an example, the portion of direct labor in the costs of the drilling contractor amounted to 27-37 percent of total contractor costs, with the spread due to different rig depth categories.

Consequently, the general trend of labor costs in Canada over the study period has an important effect upon these industries. As shown in Chart 2-3, the labor cost per unit of output did not lead the rise in general price level. Indeed, the return to labor did not increase during the initial period of the rise in price. However, after a lag, the loss of real return was regained during the latter part of the period, particularly in 1975. These increased labor costs occurred concurrently with a recession in the economy, and became a part of the cost-push effect upon prices. As a result of these factors, the average industrial wage per unit of output rose some 40 percent over the review period.

In addition, two general conclusions can be made with respect to the Canadian labor markets. First, overall returns to labor tend to respond to the real cost of living, although there

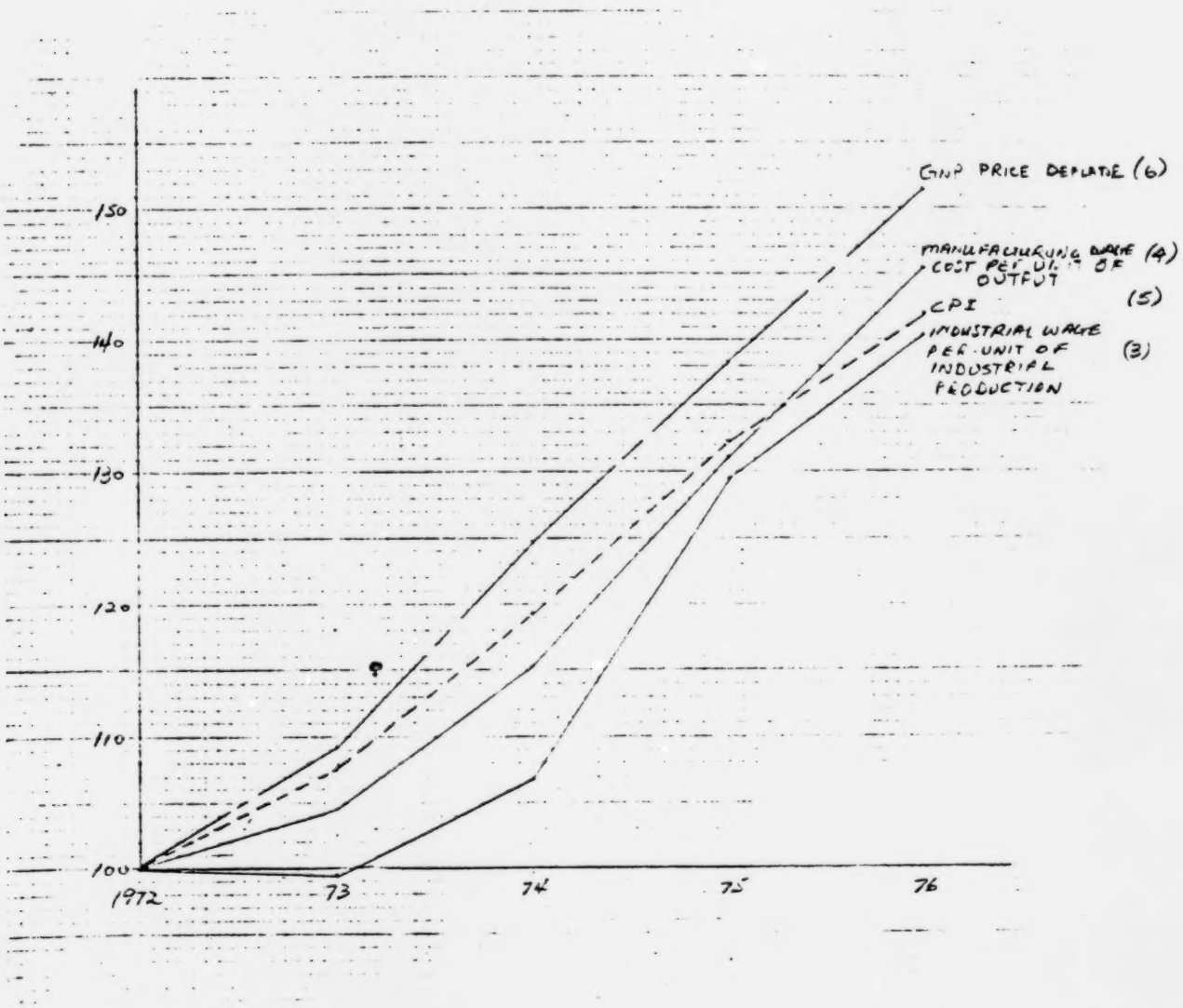
CHART 2-3

LABOR

YEAR	(1) INDUSTRIAL PRODUCTION INDEX	(2) INDUSTRIAL COMPOSITE WAGE INDEX	(3) (2) (1)	(4) MANUFACTURING WAGE COST PER UNIT OUTPUT INDEX	(5) CONSUMER PRICE INDEX	(6) GNP PRICE DEFLATOR INDEX
1972	100	100.0	100.0	100.0	100.0	100.0
1973	108	107.2	99.3	104.7	107.5	109.2
1974	112	119.7	106.9	115.1	119.2	124.8
1975	107	138.6	129.5	131.1	132.2	138.2
1976	112[a]	157.2	140.4	145.3[a]	142	151.4

NOTE: All the data are for Canada.

[a]1976, Third Quarter.



may well be a lag in the response due to contracts over discrete periods of time or labor being 'fooled' by the dollar income for a period of time.

Second, the ability of labor to regain lost real return is very powerful. Indeed, it appears that the slack in the economy in the last half of the review period had little effect upon the overall wage gains, even with the introduction of wage and price controls.

This Chapter of the report, then, outlines the substantial rise in prices in industrialized economies that occurred during the 1973-76 period. The rise during the first half of the period was due principally to excess demand and constricted supply, whereas the rise during the last half was due largely to labor and manufactured goods adjusting to the previous inflation. Consequently, the basic inputs into the drilling and field construction industries experienced price rises throughout the review period, and these were directly passed through to the petroleum industries.

CHAPTER 3

DRILLING COSTS

The cost experience of the drilling industry from 1973-76 was studied with particular emphasis on the costs of the drilling contractor, including equipment, labor and camp expenses, and the drill bits, drill pipe and collars, and casing and tubing required. These costs make up some 70 percent of the total cost of a typical well. Also, because the cost of drilling is a major part of exploratory expense, the results of this analysis give an indication of the trends in exploration costs.

Before proceeding further, however, a brief analysis of the cost of drilling a typical well will be made to give perspective to the matters discussed later in the report.

As shown in Table 3.1, the drilling contractor, who provides the drilling rig complete with drill pipe and collars, the labor to man the rig and possibly the drill bits, constitutes the largest single cost component. As this well was not dry, the cost of steel products, such as casing, tubing, and well head assemblies was also significant. Clearly, if a well were dry, the cost component of the drilling contractor would increase.

3.1 Introduction

Any discussion of exploration and drilling costs during 1973-76 must be viewed in the context of changes in the world

TABLE 3.1

COST COMPOSITION AND COMPARISON OF TYPICAL WELL[a]

Cost Component	1973 Composition of Total Cost (%)	1973 Component Cost Index (1973=100)	1976 Composition of Total Cost (%)	1976 Component Cost Index (1973=100)
Location	2.8	100.0	2.8	160.5
Drilling Contractor	35.8	100.0	35.8	162.8
Camp and Supplements	6.7	100.0	7.6	187.6
Service Rig	4.0	100.0	3.4	138.0
Mud and Chemicals	4.9	100.0	3.4	139.5
Cementing	2.1	100.0	2.4	150.7
Casing	19.9	100.0	17.8	145.7
Tubing	7.9	100.0	8.7	177.3
Well Head	5.2	100.0	5.3	165.9
Transportation	4.7	100.0	4.8	167.4
Tools, Logging, etc.	6.9	100.0	8.0	188.8
Total	100.0	100.0	100.0	162.1

SOURCE: Pacific Petroleums Ltd.

[a]Drilled to 6,600 feet.

price for petroleum.

In general, as demand exceeds supply, new, higher cost supply is introduced because the excess demand has raised the price to a profitable level. Ideally, this results in orderly price movements which can be predicted through a knowledge of supply, demand, and the cost of new supply.

However, the huge rise in the price of crude oil in late 1973 caused a large amount of heretofore uneconomic resources to become economic. This, in turn, resulted in a concerted effort directed towards the exploration of new petroleum reserves as well as other energy sources.

With this background, the remainder of this Chapter examines the effects of various parameters upon the cost experience of drilling from 1973-76.

3.2 Demand for Drilling and Its Influence on Costs

Commencing in 1972, the demand for drilling, as measured by average drilling rig activity, started to grow in the United States and Canada, and the crude oil price rises of 1973, and thereafter, caused a substantial world-wide increase in the demand for drilling services. In the North American drilling industry, this was the first sustained upswing in overall demand since the mid-1950's as shown in Chart 3-1.

There are several factors which influence the demand for drilling, and many of these factors noted below cause fluctuations both throughout the industry and within its segments.

CHART 3-1

ROTARY DRILLING RIG ACTIVITY[a]

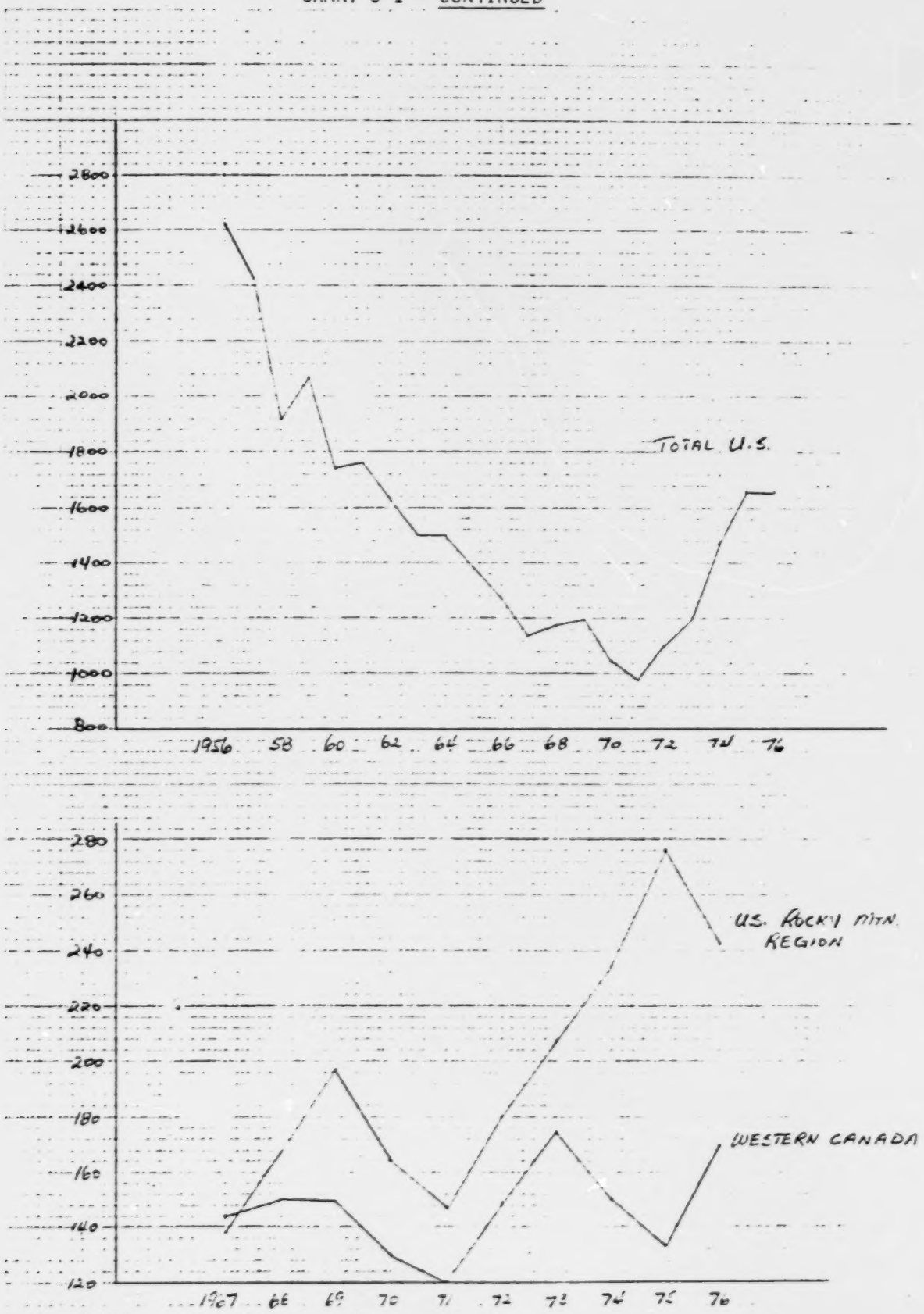
YEAR	TOTAL U.S. ACTIVITY	WESTERN CANADA ACTIVITY	U.S. ROCKY MOUNTAIN REGION ACTIVITY[b]
1956	2619		
1957	2429		
1958	1923		
1959	2074		
1960	1746		
1961	1763		
1962	1637		
1963	1501		
1964	1502		
1965	1388		
1966	1270		
1967	1135	144	138
1968	1171	150	167
1969	1195	149	197
1970	1025	131	164
1971	975	120	147
1972	1108	148	180
1973	1196	175	207
1974	1472	151	234
1975	1659	133	276
1976	1658	169	242

SOURCE: The Drilling Contractor (Jan-Feb, 1977); Oil and Gas Journal (Jan. 31, 1977).

[a]Activity is defined as making hole.

[b]Includes Colorado, Kansas, Montana, North Dakota, Utah and Wyoming.

CHART 3-1 - CONTINUED



3.2.1 Seasonality

In Canada, the effect of seasonal changes causes fluctuations in rig activity[1] which are felt industry wide, and which result in a discontinuity of use of the resources which are employed in the industry. A shorter period of time is available for work, yet many of the costs are fixed, causing higher charges during periods of activity. As well, the demand discontinuity results in variable cost input factors becoming unemployed at certain times of the year, and this is particularly true of the labor used in the drilling industry.

3.2.2 Depth of Drilling

Another factor in the demand for drilling is the depth of favorable geological prospects. Differences in the depth of those prospects results in a differentiated market where a heavy demand for shallow wells does little for the business of a drilling contractor who specializes in deep holes.

With respect to the costs of drilling, a difference in depth can result in substantial differences in the constant dollar costs, which are basically due to two factors. First, the equipment used to drill to deep horizons requires considerably more

---

[1] The seasonal demand peaks in January and February with about 80 percent of the rigs operating, and it bottoms in April and May when 20 percent of the rigs are operating. From this low level of demand, the percent of rigs operating increases steadily through to January.

capacity than equipment for shallow horizons, and this extra capacity costs more to install. Second, there are decreasing returns to scale in the drilling business which result in deeper holes requiring more time per foot-drilled than shallower holes. This added time, which is mostly due to the time required for tripping in and out of deeper depths, compounds the extra costs of greater capacity. As an example of these factors, the daily charges of a drilling contractor to drill a 16,000 ft. well at any time during the review period would be some 55 percent greater than for a 4,000 ft. well.

3.2.3 Location, Including Frontier Areas

A further factor in the costs arising from the nature of the demand for drilling is the location of favorable geological prospects. The cost of transporting in traditional areas has risen considerably as is evident by the 65 to 75 percent rise in hourly truck transport charges over the review period. While there can be substantial costs associated with various locations in the traditional drilling regions of Western Canada, it is in the frontier regions that location most heavily influences the costs and, hence, demand. This is due to several factors.

First, the drilling equipment required in the frontier regions must be specially developed to handle the particular area, and such equipment must have back-up systems for safety and to avoid expensive down-time. In addition, where the drilling equipment is used in offshore work, a structure must be used to support

the rig. In the Beaufort Sea, the use of artificial islands and drillships is very costly in and of it-elf, but it also requires the further costs of supply ships, rescue ships and other auxillary equipment and services.

Second, the cost of transporting equipment and personnel to the frontier regions is very great. The estimated cost of moving a drilling rig from Alberta to the MacKenzie Delta in 1976 was $1 million. That amount of money would pay for about 200 days of work for a 12,000 ft. rig in Alberta. As well, the need to have large investments in ships or other floating structures for rigs used in offshore work creates a large overhead which must be recognized in the cost of transportation. For example, a drillship can cost $60,000 per day just to move from the North Sea or the Gulf of Mexico to the East Coast of Canada.

Third, the need to provide reasonable working conditions in difficult drilling locations is important for the retention of qualified labor. Also the drilling operation itself is likely to be working in environmentally sensitive areas which require special equipment, materials, personnel, and procedures to lessen the risk and cost of environmental damage.

Clearly these factors place the drilling cost of frontier areas on a new plane when compared to the costs associated with traditional areas, and they considerably influence the demand for drilling. The heavy investment required eliminates many operators from drilling because they do not have the financial resources to undertake the endeavour. Also, the heavy investment, when combined

with the costs of transprtation, results in very high fixed costs which can only be rationalized by spreading the costs over several wells.

The need to have a multi-well drilling program to be able to rationalize the expense of drilling in prospective frontier areas requires a long run stability in financial, environmental and operating parameters. Thus, uncertainty, no matter what its cause, plays an important role in frontier drilling demand because the time horizon needed to allow for planning and a reasonable return on investment is considerably longer than in the traditional areas.

In conclusion, the nature of the demand for drilling in Canada will influence costs due to seasonal, depth and location factors which directly affect the continuity of demand for drilling services. Although changes in the depth and location factors can greatly change constant dollar drilling costs, there were substantial inflation cost increases over the review period. These were somewhat tempered by an overall increase in the continuity of drilling demand. Specific factors which influenced the inflation cost increases, and continuity of demand are discussed in the following section.

3.3 Factors in the Behaviour of Drilling Costs, 1973-76

While the preceeding section indicated some of the factors which influence the costs of drilling at any point in time, this section discusses the factors which influenced costs over the study period.

3.3.1 Drilling Equipment

In examining the major components of the overall cost increase in drilling, the cost of drilling equipment plays a major role, and it is the focus of this section of the study.

3.3.1.1 Drilling Rigs

A drilling rig is made up of components supplied from many sources which are principally located in the United States, and the size of the components determines the depth capacity of the rig. Rigs are usually bought with a package of standard components, and then supplemented by other equipment to meet specific needs.

There is both a new and used drilling rig supply, and the price difference between the two supply sources has played an important part in the cost of drilling over the review period. As has been shown in Chart 3-1, the demand for drilling in North America, and particularly the United States, started a steady decline in the mid-1950's continuing through to 1971. This resulted in a growing supply of good used drilling equipment, and caused the price of such equipment to drop to 20-30c per $1.00 relative to new equipment during 1971 and part of 1972. Consequently, drilling contractors could replenish or add equipment to their operations at attractive prices.

However, the increased demand for drilling, which commenced in 1972 and has continued to date, caused the excess supply of drilling rigs and equipment to disappear. In fact, the price of used equipment relative to new equipment has increased to the cur-

rent ratio of 80¢ per $1.00, and most contractors feel this makes new equipment a good, if not a better deal.

Furthermore, the cost of new equipment has risen between 75 and 125 percent over the 1973-76 period, and this increase, when combined with the change in relative prices noted above, results in a five to seven fold increase in the price of good used equipment. For example, a good used drilling rig with a 7,500 ft. capacity cost between $200,000 and $250,000 on the United States market in 1972, and a new rig with the same capacity would cost about $1,460,000 in 1976.

This magnitude of price increase has also affected the components of the rigs, and has resulted in a substantial increase in the replacement costs of components and rigs from 1973 to 1976. This situation is particularly important where operator or government standards require new component additions to the rigs.

3.3.1.2 Offshore Rigs

Prior to the review period, there was a surge in the construction of offshore drilling rigs of all types, but particularly for semi-submersibles. The crude oil price increases of 1973 acted to further increase the demand and construction of offshore rigs.

As can be seen from Chart 3-2, the world-wide construction and equipping of the offshore rigs peaked in 1974 which was about the same time the economies of the industrialized world peaked. Thus the drilling industry became a part of the heavy demand pressures which were placed on basic inputs, such as steel, during the concurrent world economic boom.

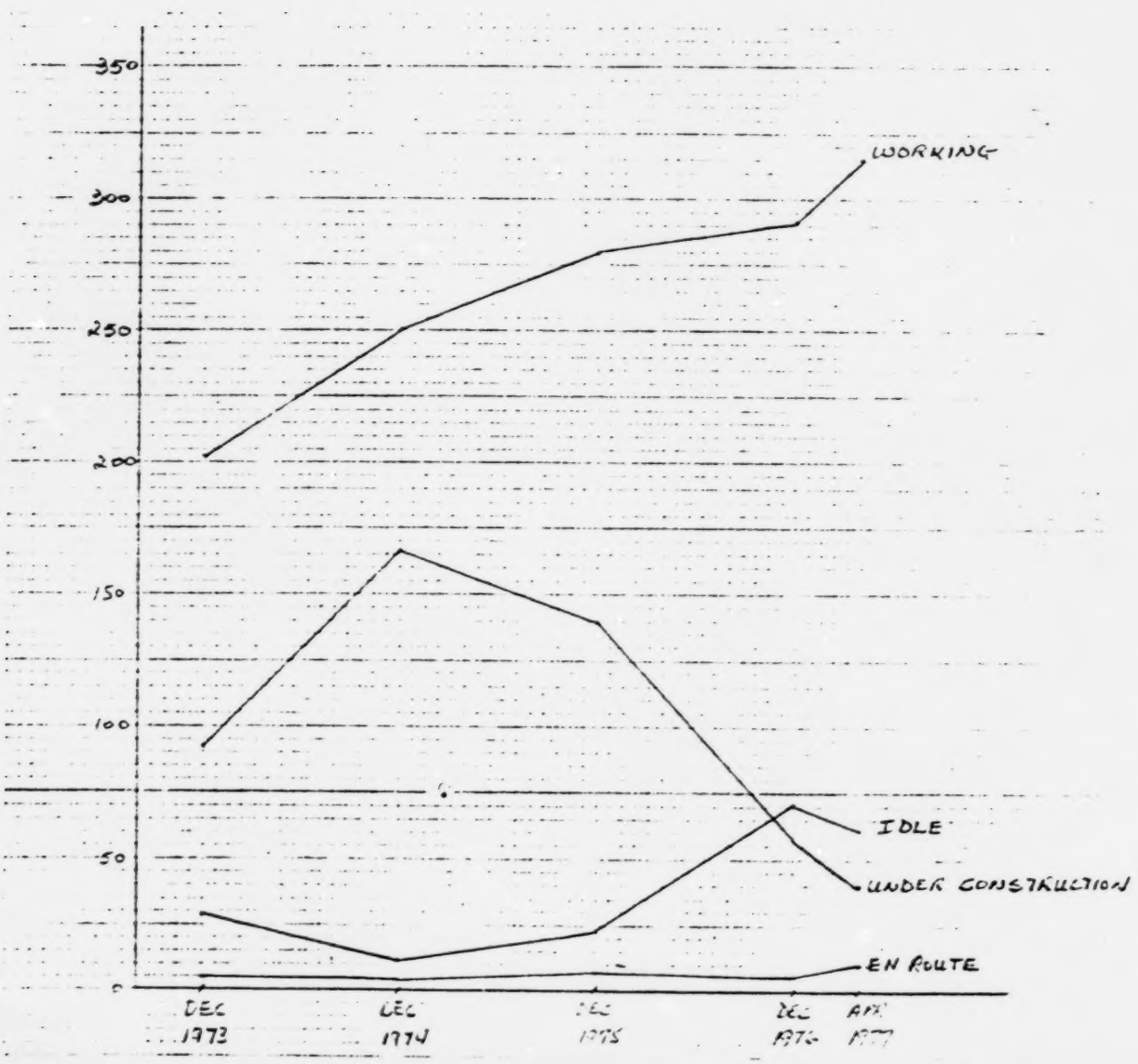
CHART 3-2

OFFSHORE DRILLING RIGS

YEAR	RIG STATUS			
	WORKING	EN ROUTE	IDLE	UNDER CONSTRUCTION
DEC., 1973	202	5	29	92
DEC., 1974	250	4	11	167
DEC., 1975	280	7	23	140
DEC., 1976	291	6	71	57
APR., 1977	315	10	61	40

SOURCE: Offshore (April, 1977).

NOTE: These data are for Worldwide Offshore Drilling Rig Activity.



In addition, demands for material and components to supply the new offshore rigs had to compete with a renewed demand for equipment for land rigs. The resulting price increases directly affected the costs of drilling equipment for the Canadian drilling industry. This was because much of the equipment in the drilling industry is produced by a relatively small number of firms in the United States, and the resultant bottlenecks in supply combined with the heavy demand for equipment to force some price increases of 125 percent over the review period[1].

During the latter half of the review period, the general world demands were reduced, but, as was discussed in Chapter 2, the prices for basic inputs continued to climb. However, while the prices rose, the supply availability of basic inputs improved, and so did the availability of drilling equipment. The drop off in the construction of offshore rigs during 1975 and particularly 1976 played an important role in reducing some of the excess demand in the drilling equipment market[2].

It is apparent, then, that heavy demands for drilling equipment to supply offshore and land rigs combined with the concurrent world economic boom to produce very substantial rig component price increases over the review period.

---

[1]For an analysis of offshore rig supply, demand and cost, see Appendix B.

[2]See Appendix A, Table A.2 for the effects upon drilling equipment and well-bore servicing companies due to the increased demand.

3.3.1.3 Drill Pipe, Drill Collars, Casing and Tubing

These products are made of steel and, consequently, they were subject to the steel market conditions as discussed in Chapter 2. In addition to the price increases in steel, however, these products were also affected by their own market conditions.

The demand for new drilling equipment during the review period was particularly heavy for drill pipe and collars. An important component of these high quality steel products is the tool joint which is welded to each end of the pipe and allows the pipes to be connected together. There were only two companies which affix tool joints in North America during the review period, and because the demand for drill pipe and collars was so heavy, it exceeded the capacity of these companies to fit tool joints. The situation reached the point where the supply of drill pipe and collars, even at very high prices, could not be easily secured.

The quantity demanded of these goods, however, was reduced over the last part of the review period, mostly because the construction and equipping of new offshore rigs slowed. In fact, the price of drill collars has been reduced somewhat in the latter part of 1976, but the price increase over the review period remained very substantial. For example, the price of drill pipe rose from $8-9 per foot to $20 per foot between 1973 and 1976.

In the casing and tubing markets, there was excess demand until about May of 1975 when the demand lessened to the extent that a buyers' market started to develop. This has continued over the remainder of the review period, and has resulted in a smaller

increase in prices for casing and tubing products compared to drill pipe. The price of casing from outside North America has actually dropped in 1976 to price levels equivalent with domestic casing.

In conclusion, the particular structure and parameters of the drill pipe and collar, casing and tubing markets resulted in different price movements over and above the price increases which occurred in the steel market. Over the review period, the price increases in these markets were 120 percent for drill pipe, 100 percent for tubing and 70 percent for casing. The supply constriction of the tool joints had a substantial price effect, and the lack of a Canadian tubing supplier combined with casing imports from outside North America caused much of the difference between the tubing and casing price increases.

3.3.1.4 Drill Bits

Over the review period, the greater use of new technology in the drill bit resulted in an increase in drilling efficiency of between 10 percent and 100 percent, depending upon the conditions of use. The new technology was a combination of tungsten carbide inserts (TCI) in the cones, a sealed bearing, and improved cutting structure. Much of this technology had existed before 1973, but it was steadily improved over the period, and these new bits increased their market share appreciably.

The chief benefit of the TCI, sealed bearing bit is the increased time-on-bottom which it allows. This is particularly important where a deeper hole is being drilled, because it reduces

the number of trips, and therefore improves the returns to scale factor[1].

However, these advances did not come cheaply, as shown by Table 3.2.

While the newer bits appear very costly when compared to the older bits, the reductions in the cost of operation and maintenance of the rig, again due to the newer bits requiring fewer trips, makes them more attractive.

In conclusion, there is considerable competition amongst the four major drill bit suppliers to introduce technical innovation in their industry. The innovations noted above have worked to increase the efficiency and reduce cost increases during the review period,[2] although the magnitude is difficult to assess on an overall basis due to different drilling conditions causing widely variable drill bit performance.

---

[1] An example of this benefit is found in drilling records for two wells drilled in similar geology to a depth of 7,420 and 7,400 feet. The latter was drilled using 12 conventional tooth bits and taking 1.18 days for tripping. The former well used 4 TCI sealed bearing bits and needed 0.07 days for tripping. This is an extraordinary case, but does offer order of magnitude comparisons.

[2] See Appendix C for further comment on the structure and behaviour of the drill bit business in Canada.

TABLE 3.2

PRICE COMPARISON OF DRILLING BITS

	1973	1976	PERCENT INCREASE
Tooth Bit (conventional)	100	171	71
TCI Sealed Bearing Bit	810	1011	25

NOTE: Index 100 = Price of Tooth Bit in 1973

3.3.1.5 Operator Specifications

Over the review period, the operators, in general, demanded better overall quality control of the drilling process. The quality of muds used is an example of the increased standards employed.

To improve quality control, rigs often have to be equipped with special equipment or instruments, and operators often have to rent these items to make a rig meet their standards. Whether such captial improvements are supplied by the contractor or operator, the cost of increased quality control has had its part in the increased cost of drilling a well.

3.3.2 Drilling Contractor

As shown in Table 3.1, the largest single portion of the costs of drilling a well is for the services of the drilling contractor. The portion is in the range of 30 to 40 percent, and it includes the drilling rig, drill pipe and collars, and the labor to operate the equipment. The contractor is usually chosen through the process of competitive bidding, with the bidding based either upon footage or day work rates.

With a footage contract, the contractor sets a price per foot to complete the well as described by the operator. That is, it is a flat rate which tends to put the risk of cost increases due to difficulties on the contractor. However, the day work arrangement is, in effect, a daily fee for the rental of the contractor's men and equipment. As a result, day work contracts

place the risk of costly difficulties on the operator.

3.3.2.1 Day Work Rates

The Canadian Association of Oilwell Drilling Contractors (CAODC) is an organization whose members are drilling and well servicing contractors, with associate memberships from other well bore service companies. Over the review period, as well as for several years before 1973, the CAODC annally published a book detailing the recommended minimum daily work rates for drilling rigs. The rates are classified by geographic location and rig depth capacity. The daily work rates come from adding a profit margin to total daily costs, and an analysis of the costs used in the CAODC book is shown in Chart 3-3. The average increase in these costs for the 1973-76 period is 72 percent, with the fuel, water, insurance, maintenance, capital replacement, drill pipe and drill collar costs taking a greater share of the total cost in 1976 than they had in 1973. Direct labor and administration expense had a smaller share of 1976 costs than they had in 1973.

In addition to the daily work rates for the rig and equipment, the charges for auxillary equipment and material also increased significantly as shown in Chart 3-3, and, in 1974, provisions which automatically passed through all escalation in fuel, wage and salary, and catering costs were added to the standard terms of work.

CHART 3-3

COMPOSITION OF CAODC RECOMMENDED DAILY MINIMUM CHARGE (%)

Year[a]	OCT. 1971	NOV. 1972	OCT. 1973	OCT. 1974	OCT.. 1975	WELL DEPTH
1. Direct Labor	37.9	39.2	40.8	39.6	38.0	0 - 2,000 ft.
2. Admin. & Toolpusher[b]	28.8	28.1	26.3	26.3	21.6	
3. Insurance, Maintenance, & Capital Replacement	24.4	24.2	24.4	23.9	28.3	
4. Fuel & Water	7.6	6.8	6.7	8.0	10.1	
5. Drill Pipe & Collar	1.4	1.5	1.7	2.1	1.9	
1. Direct Labor	32.8	34.7	35.6	33.0	30.9	8,501 - 9,500 ft.
2. Admin. & Toolpusher[b]	20.6	20.4	18.9	18.1	18.0	(8,001 - 10,000 ft.
3. Insurance, Maintenance, & Capital Replacement	32.0	31.2	31.2	32.9	31.4	in Oct. 1975)
4. Fuel & Water	9.3	8.5	8.5	9.6	10.4	
5. Drill Pipe & Collar	5.3	5.2	5.7	6.4	7.5	
1. Direct Labor	27.0	28.6	29.1	26.6	27.3	15,501 - 16,500 ft.
2. Admin. & Toolpusher[b]	16.9	16.9	15.4	14.6	10.9	(15,000 + ft. in
3. Insurance, Maintenance, & Capital Replacement	38.2	35.2	35.3	36.9	38.6	Oct. 1975)
4. Fuel & Water	10.4	11.9	12.1	12.7	11.9	
5. Drill Pipe & Collar	7.4	7.5	8.2	9.2	11.4	
Number of Operating Days Used to Calculate Daily Rates	118	140	155	180	170	0 - 3,000 ft.
					145	3,000 - 12,000 ft.
					185	12,000 - ft.

SOURCE: Canadian Association of Oilwell Drilling Contractors

[a]The dates represent the commencement of the one year period over which the rates are in effect.

[b]Includes toolpusher and expense, administration, and communications.

SUPPLEMENTARY DRILLING COSTS AS RECOMMENDED BY THE CAODC
(OCT., 1971 = 100)

	OCT. 1971	NOV. 1972	OCT. 1973	OCT. 1974	OCT. 1975
1. Transportation of labor:					
- $/mile/man (camp)	100	114	114	186	214
- $/day/man (non-camp)	100	114	129	157	186
2. Four unit camp for 20 men, Alberta location.	100	109	111	160	197
3. Extra charge for camp used during winter	100	100	138	175	225
4. Fuel charge for camp used during winter	100	100	133	167	200

3.3.2.2 Changes in the Nature of the Contractor Industry

The drilling contractors have developed a strong industry structure within which they vie, through rivalry, for drilling contracts. The CAODC acts as the industry's co-ordinating body, and this type of structure affects the price of drilling services. But, the structure had been in effect long before the 1973-76 period, and it is probable that it did not add to the increase in costs during the review period[1].

However, there were two changes in the nature of the contracting industry which did affect costs over the 1973-76 period. The first of these involved changes in the pass through of costs from contractors to operators. The introduction of the use of replacement costs of equipment versus depreciation cost, and the inclusion of automatic escalator clauses applied to labor, fuel and catering costs in the standard contract terms resulted in higher costs and faster pass throughs to the operators.

The second change deals with the number of rig operating days per year which is a very important cost factor. During the review period, there was an increase of some 20 percent in the number of operating days used by CAODC for the recommended rates. This increase was based upon contractor experience. While an increase in operating days lowers costs simply because fixed costs are spread over more time, there are other economic gains associated with more operating days. The principal one is the increased continuity of rig and personnel employment which results.

---

[1] For a discussion of the structure and behaviour of the contracting business, see Appendix D.

From the standpoint of equipment, more operating days result in an improved cash flow which can allow proper rig maintenance and improvement as the need demands. As well, a steadier demand reduces the need to take high profits during heavy demand periods, and may even reduce the profit margin if the demand is steady enough to reduce uncertainty. Further, an increase in operating days should tend to alleviate contractor fears that new innovations will reduce operating days to hardship level. However the contractors have an overwhelming concern for operating days which often leads to a slow and cautious introduction of new innovations[1].

In conclusion, then, the changes in the nature of the drilling contractor business were relatively minor in the overall effect upon the cost of drilling. However, they did serve to strengthen the basic structural and behavioural aspects of the industry which had been in effect prior to 1973. Consequently, cost increases to the operator which came from the contractor were mostly due to the pass through of cost increases in equipment and labor.

---

[1] It should be noted that where innovation is not a prime focus of the competition amongst firms in an industry, there is typically a cautious and slow movement to introduce innovation.

3.3.2.3 Labor

The cost of labor is the largest single expense of the contractor, as shown in Chart 3-3, and it is basically split between administrative and senior operating personnel who are kept on staff year round, and other operating personnel who work when the rigs work. These latter workers are usually low-skilled and are able to transfer their labor amongst industries which require low-skilled manpower.

There is no labor union organization in the drilling contractor industry but there are standard levels of remuneration which are established by the CAODC. To do this, the CAODC estimates the opportunity cost of the worker transferring his labor to other industries. That is, the gross income per year available to the worker in competing industries, such as construction or government service, is used as a bench mark for setting the income levels of the worker in the drilling industry.

As a result, the remuneration to labor in the drilling business is tied, indirectly, to the bargaining process between employees and employers in other industries. As shown in Chart 3-4, the construction industry appears to be a main source of competition for labor because increases in labor earnings from drilling followed it closely.

Consequently the labor costs of the drilling contractor were not only influenced by the general rise in labor costs throughout the economy as discussed in Chapter 2, but also by the fact that the demand for construction labor in Alberta was very heavy

CHART 3-4

AVERAGE WEEKLY EARNINGS[a] IN PRAIRIE REGION FOR PETROLEUM CONTRACT DRILLING AND OTHERS (1972 = 100)

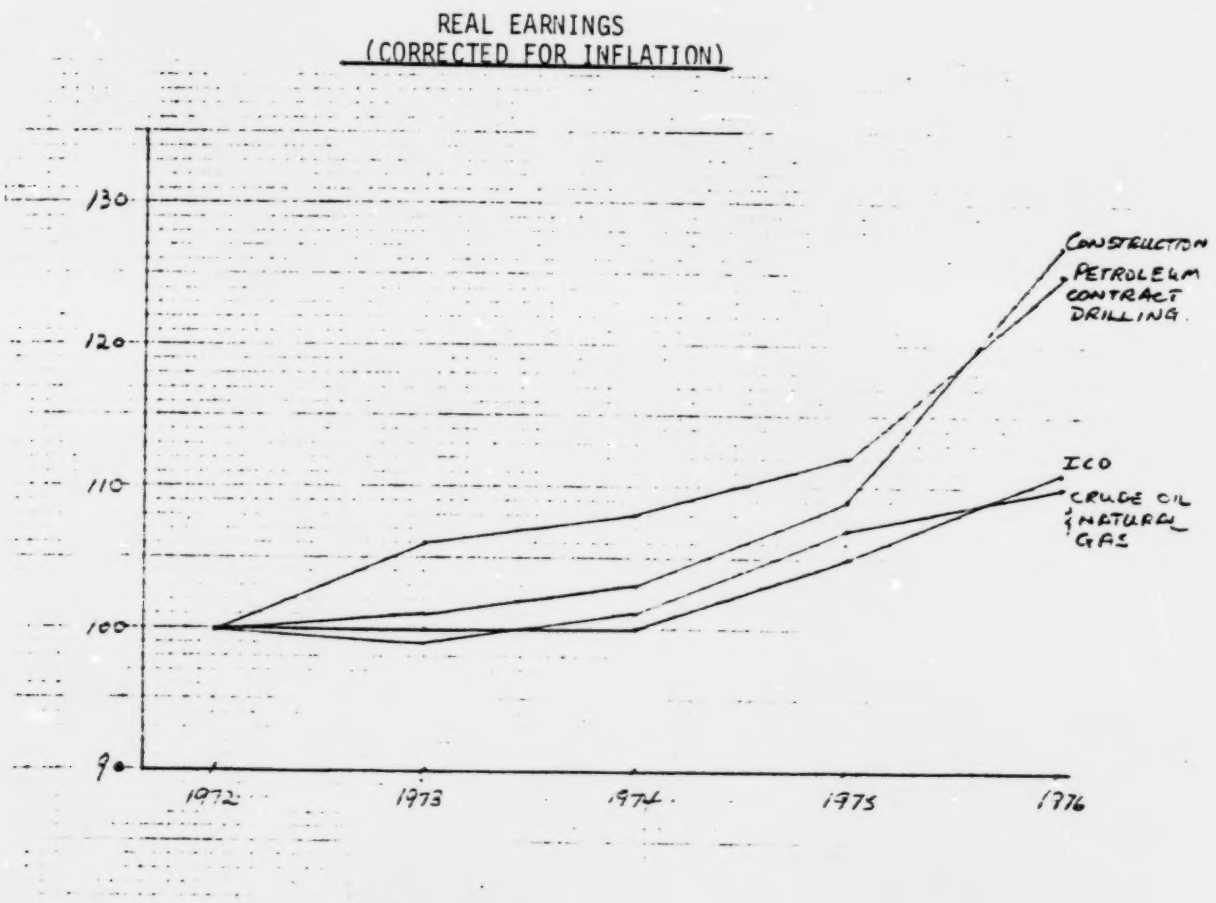
	NOMINAL EARNINGS					REAL EARNINGS[b]			
YEAR	CRUDE OIL & NATURAL GAS LABOR[c]	PETROLEUM CONTRACT DRILLING LABOR	CONSTRUCTION LABOR	ICO LABOR[d]	CONSUMER PRICE INDEX	CRUDE OIL & NATURAL GAS LABOR	PETROLEUM CONTRACT DRILLING LABOR	CONSTRUCTION LABOR	ICO LABOR
1972	100	100	100	100	100	100	100	100	100
1973	107	124	108	107	108	99	106	101	100
1974	121	139	122	120	119	101	108	103	100
1975	141	160	144	139	132	107	112	109	105
1976	157	176	179	157	142	110	125	127	111

[a] It should be noted that earnings are a function of the wage rate and the demand for labor.

[b] Determined by nominal earnings reduced by CPI Index. Small discrepancies due to rounding monthly data.

[c] Includes labor used in plants, refineries and fields.

[d] Industrial composite.



during the study period. This led to construction wage settlements which were considerable, and those settlements found their way through to the drilling industry, amongst many others.

The general trend in drilling contractor labor costs, as described above, was also influenced by several other factors. First, while the total income to the employee was considered by CAODC in its calculations, the incorporation of fringe benefits for laborers were not on a par with competing industries. This is almost certainly the result of no employee representation in the wage determination process. Second, many of the workers employed by the drilling industry are farmers from Western Canada who are available in the winter during the peak drilling months. This results in a supply of labor which can be trained over time, but which is less susceptible to the competing careers in other industries. Third, the skilled labor in the drilling industry is in demand throughout the world, and this results in a need for the contractors to pay rates competitive with those outside Canada.

In conclusion, the net result of all the above factors has been a 70 percent increase in the hourly cost of labor for drilling. However, because some of the labor expense is fixed the increased number of operating days reduced the daily charge for labor. This resulted in a 62 percent increase in labor costs as reflected by the daily work rate of the CAODC.

3.3.3 Government

The role of government in the cost increases which occurred in the drilling industry between 1973 and 1976 may be split into two parts. The first part results from those actions by government which influenced the overall demand for drilling in Canada, and the second part deals with actions which directly influence the cost of drilling.

In looking at the effects on overall demand for drilling resulting from government action, Chart 3-5 shows the drop in the number of rigs located in Canada in 1975. This was a direct result of reduced drilling demands due to disagreements between levels of government with respect to the price of production and the disposition of revenues. The rigs which left Canada, a net total of 68, were either sold or placed in work elsewhere. Most of the rigs which found work outside Canada went to the Rocky Mountain area of the United States where demand for rigs was very heavy. (See Chart 3-1.)

The response by operators to improved economic parameters for production and drilling resulting from government measures during 1975 and 1976 has increased the demand for drilling and has brought many of the rigs back to Canada. However, the lack of definitive government regulations in frontier areas combined with other factors such as jurisdictional disputes and pipeline construction uncertainties, continue to reduce the demand for drilling.

CHART 3-5

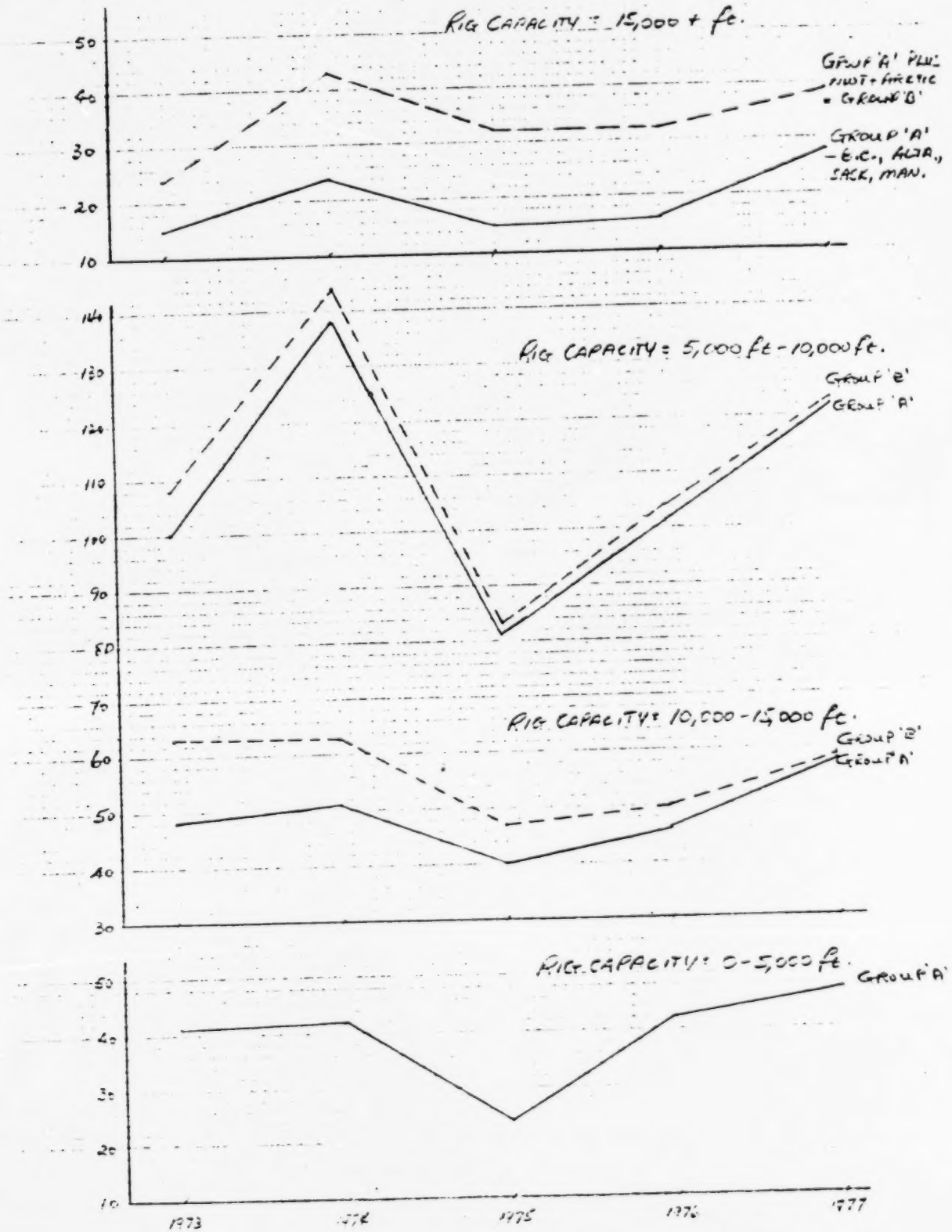
DRILLING RIGS LOCATED IN WESTERN CANADA[a]

DEPTH CAPACITY OF RIG	1973	1974	1975	1976	1977
1. FOR ALBERTA, B.C., SASKATCHEWAN, AND MANITOBA (GROUP A)					
0 - 5,000 ft.	41	42	22	42	47
5,000 - 10,000 ft.	100	138	81	101	122
10,000 - 15,000 ft.	48	51	40	46	58
15,000 + ft.	15	24	15	16	28
SUB-TOTAL	204	255	158	205	255
2. FOR ABOVE PLUS N.W.T. AND ARCTIC ISLANDS (GROUP B)					
0 - 5,000 ft.	41	42	22	42	47
5,000 - 10,000 ft.	108	144	83	104	123
10,000 - 15,000 ft.	63	63	47	50	59
15,000 + ft.	24	43	32	32	39
TOTAL	228	292	174	228	268

SOURCE: Petroleum Engineer (Mar., 1973-77)

[a]These figures are for the months of January and February in the year shown.

CHART 3-5 - CONTINUED



As a result of the government-induced fluctuation in demand, there were substantial moving and other dislocation costs during the review period, and some of these still linger where there is short supply of deep rigs, as in Alberta, and where other rigs sit idle awating new activity, as in the MacKenzie Delta. The cost increases associated with these imbalances in supply and demand are compounded because the uncertainty which the demand fluctuations cause adversely affects planning and future expectations.

Turning to the other aspect of government action affecting the cost of drilling, the introduction of government legislation or regulations directed at drilling included the environmental regulations published in 1975 in Alberta. These regulations formalized a set of guidelines which had been in effect during the review period, and they pertained to the final condition of the lease with particular concern for the disposal of sump fluids.

An analysis of the sump clean-up costs for 84 wells drilled during the review period shows that the average depth and cost were 9,755 ft. and $7,940 per well, respectively. This yields an average of 81.4c per foot drilled which is something less than 3 percent of the total well cost to that depth. This is a relatively small cost increase, and it is discrete in the sense that the regulations are now in place and constant dollar costs would only increase if those regulations become more severe. Consequently, these regulations caused a step increase in that particular element of the drilling cost, but they did not change the rate of increase in costs after their implementation.

3.4 Factors in the Future Behaviour of Costs

3.4.1 Concurrent World Economic Booms

The concurrent boom of 1973-74 was a unique experience in the economic history of the modern world. It is not clear if the boom resulted from coincidence, or if the world economic structure and behaviour has become more conducive to such a boom.

Most countries have been emerging slowly from the recent recession, with only moderate rates of growth in 1977 but with price increases still at a substantial rate. In Canada, for example, the rate of growth of the economy in 1977 is not expected to be any higher than 4 percent although price increases are expected to exceed 6 percent. Whether or not price controls are removed, general price increases are not likely to lessen much further in 1978, especially if the economy moves closer to its overall growth potential.

Such a move, both in Canada and other industrialized economies must reflect the general condition that

> The world economy can achieve continued economic growth, provided governments maintain a cautious and selective approach toward economic stimulus, so as not to reaccelerate inflation[1].

Because the largest source of cost increases in the drilling industry over the review period was due to the price rises in

---

[1] Paraphrased conclusion of 1977 report to OECD by eight economists; (The 'McCracken Report'), "Economic Diary", Business Week, (June 27, 1977), 19.

the economy, it is important that the general economic trends be watched by industry parties. This will be required whether or not there is a concurrent boom of world economies, because individual economies, and particularly the United States and Canada, will experience changes in economic activity due to business cycle fluctuations and the effects of government economic policies.

Specific indicators to be watched include the rate of change in world commodity price indices; the level of industrial production of Canada, the United States and the other OECD countries, and the resulting level of capacity utilization; the wage per unit of output in the economy as well as in specific industries such as construction in Alberta and steel in the United States and Canada; and major changes in the structure of industries with basic inputs into the economy.

3.4.2 The Drilling Market

The second largest factor in the rise of drilling costs resulted from the large increases in demand for drilling equipment which peaked coincidentally with the heavy demands for all manufactured goods during the concurrent boom. The very heavy demand for drilling equipment in that period, and the subsequent, strong demand to date was prompted by a huge price increase for crude oil and a new urgency in the demand for new energy sources.

The price of crude oil is likely to rise in a more orderly and reasonable way than it did during the review period. Thus, while the world-wide demand for new energy sources will continue to be strong and will continue to promote demand for exploration

and for drilling, there is unlikely to be a large new surge in the demand for drilling equipment.

As well, two more factors are important. First, even if there is a new surge in demand for drilling equipment, it may not coincide with an economic boom, and thus not result in a supply squeeze for basic material and labor. Second, new sources of supply for several types of equipment have or are about to come into the market, and this will tend to eliminate some of the bottlenecking which occurred in 1974-75. It should be noted however that, where the supply of equipment comes from outside Canada, foreign exchange rate fluctuations will result in added costs or benefits depending upon the rate movements.

As the cost of drilling increases, there has been, and will be, more emphasis upon the efficiency of the whole drilling process to lower costs. This drive to increase efficiency will affect all sectors of the drilling industry including continued improvement in the timing of land sales and exploration planning. This is not to say that the competition for knowledge of potential prospects will not continue to lead to some erratic demands for drilling services, but it does imply that there is a natural course towards streamlining systems and procedures when their costs become high.

And, a final influence upon costs due to changes in the drilling market will come from the greater extent of larger, diversified corporations becoming contractors through purchasing existing, privately-owned contractors. This situation will arise be-

cause the cost of entering the oilwell drilling contracting business has risen to the point where individuals are virtually unable to afford to enter, either through buying out an existing contractor, or starting a new firm. The two main reasons for relatively high cost of entry are the inflation-induced increases in the asset value of the rigs and equipment, and the value of the going concern of a drilling firm which is presently considerable due to the strong demand for drilling services.

3.4.3 The Cost of Labor for Drilling

The cost of labor in the drilling industry is going to increase in the future, and the increase will be most pronounced in the jobs currently done by the low-skilled manpower. The rise in labor costs will be a longer term cost increase which will be influenced by several factors.

The first factor is the continuation of the recent trend to employ more experienced and trained labor to drill in difficult and demanding circumstances. It is well recognized that the labor used on a deep well in the foothills or on an offshore well must be better trained and more capable than labor used to drill a typical well at Crossfield, for example. This is not only because the drilling operations are more demanding, but also because the cost of the well, and of mistakes caused by poorly trained labor, is high.

In addition to higher standards for labor due to more costly and difficult drilling, there will be higher standards

introduced through government regulations. These regulations will require new safety and well control equipment and procedures which, in turn, will require better trained labor.

Once the employment of skilled labor becomes more widespread, there will develop a labor pool which is trained to meet the standards of drilling required by circumstances and regulations. Certainly, some of this pool will be supplied by the cyclical farm labor, but much of it will come from people willing to make a career out of drilling.

The pace at which these events occur is subject to three variables. First, a strong demand for drilling, and particularly drilling in environmentally and geologically difficult areas, will tend to increase the pace at which the trained labor pool will develop. Second, the rate at which diversified, large companies become the owners of the drilling rigs will be important. If the rate is relatively quick, then the trained labor pool will develop more quickly because the diversified firm will be more able to carry the drilling labor by employing it elsewhere when drilling demand slackens.

Finally, and most importantly, the reaction of the operators to the cost of building a trained labor pool will very much determine its pace of development. The principal factors involved in the reaction of the operators will be their demands for quality control and other drilling standards, and their ability and willingness to pay for increased out-of-pocket costs. This latter factor will not only be a function of the operator's net back, but

also of the ability of the operator to measure the benefits of out-of-pocket costs against the environmental, human or opportunity costs. This cost/benefit analysis will be more easily made by major operators, but it must also be made by small operators if a trained labor pool is to be successfully developed.

In conclusion, then, the cost of labor will increase because there will be a need to have well-trained personnel at all levels of the contractor's manpower. The pace of the development of such personnel will depend upon several factors, but the role of the operator in demanding and paying for improved labor will be the crucial variable in the foreseeable future.

3.4.4 Government

The introduction of new regulations by government will affect the costs of drilling over the next five years. Specifically, the introduction of new well control measures will require many rigs presently operating in Canada to be upgraded with new blow-out prevention equipment. This will cost between $100,000 and $250,000 per rig, and the conversions must be completed by 1980.

Changes in the weight of vehicles using Alberta's roads will require new transportation equipment to be introduced. This will result in substantially increased costs of moving rigs throughout the province. And, finally, the introduction of metric units will have a cost increase effect on drilling services, although there will be some offsetting benefits due to fewer and more standard measurements being required.

It is important to recognize, however, that these new regulations cause a step-wise, or discrete, change in the rate of cost increase, which will only affect the rate of cost increases during the implementation of the regulation, but not afterwards.

3.4.5 Summary

The cost of drilling will increase in the next five years at a rate below that which was experienced over the 1973-76 period, but above the average rate of inflation in Canada.

The prevailing rate of inflation in the economy will be incorporated into the costs of drilling through the basic inputs of steel and labor into the drilling industry.

A continued strong drilling demand, both world-wide and in Canada, will result in continued pressure on the supply of equipment and material used for drilling. The extent of price rises for drilling equipment will depend upon the reduction in supply bottlenecks, and implementation of technological gains in equipment and practices.

The cost of labor will increase both due to continued wage increases in competing industries, and due to the greater need to have trained personnel at all levels of the contractor's manpower requirements.

There will be several cost increases due to government regulations, but most of these increases will be discrete in nature. That is, they will tend to raise the cost of drilling in a single step-wise manner, and thereafter they will not affect the rate of cost increases.

CHAPTER 4

FIELD CONSTRUCTION

4.1 Introduction

This chapter studies the cost experience of the construction of field gathering systems. These systems are small-inch pipelines which take crude oil or natural gas from the well to a storage or upgrading facility.

While the portion of the construction industry which services the demand for gathering systems does have some unique aspects, it has essentially the same business environment as do all construction contractors. This environment is one of

> ... a risky business. There are often wide swings from year to year in the scale of operations of construction firms, and profits are highly variable. The financial performance of firms varies considerably among types of construction and from region to region (within Canada)[1].

Because the nature of the gathering system construction business is straightforward and not complex, it requires less study than does the drilling business whose nature has changed

---

[1] Economic Council of Canada, Toward More Stable Growth in Construction, Report of the Study on Cyclical Instability in Construction (Ottawa: Information Canada, 1974), p. 5-7.

markedly over the past decade and has, consequently, added a degree of complexity not found in this construction business.

While the composition of the costs of gathering system construction varies with factors such as location, pipe size, and time, a general view of the significance of various costs is shown in Table 4.1.

4.2 Factors in the Behaviour of Gathering System Construction Costs, 1973-76

4.2.1 Demand Characteristics for Gathering System Construction

Overall demand for gathering system construction is primarily a function of the number of new producing wells which come on stream. These, in turn, are basically a function of the demand for the product, the net back to the producer, the discovery or development rate of new wells, and the geographic location of those wells.

The influence of these factors can be seen from Chart 4-1, where the uncertainty of product price in 1974 resulted in fewer wells being connected. But, the better financial situation in 1975 and 1976, especially for natural gas, caused a significant comeback in gathering system construction.

In addition to the swing in demand as shown above, there are basically two other factors which influence the demand. One is the seasonal factor which causes discontinuity of demand, with the degree of the discontinuity dependent upon the severity of the weather conditions and its effect upon ground conditions. A second

TABLE 4.1

CONSTRUCTION COST COMPONENTS AND PORTIONS OF A TYPICAL PRAIRIE GATHERING SYSTEM

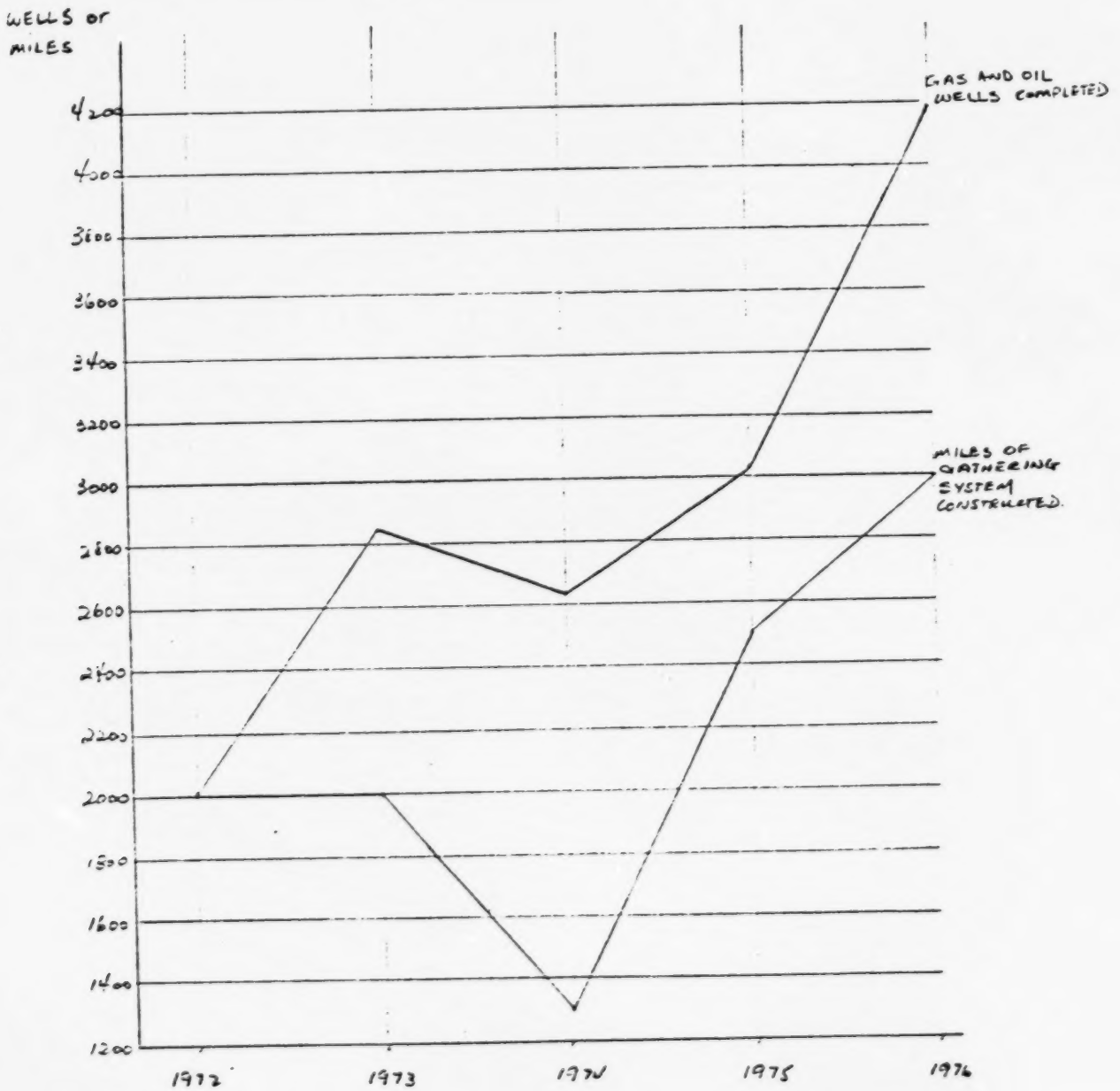
	Pipe Size and Thickness		
	2½" by 0.083"W.T.	4" by 0.095"W.T.	6" by 0.109"W.T.
	- Percentage Distribution -		
Line Pipe	22.5	28.7	33.6
Coating and Zaplok	7.6	9.6	9.9
Line Installation (contractor)	25.7	24.0	23.6
Tie-in	11.4	9.7	7.5
Valves and Fittings	8.5	9.1	9.3
Survey	4.5	3.6	3.0
Easements	8.5	6.8	5.6
Supervision and Miscellaneous	11.3	9.1	7.5
TOTAL	100.0	100.0	100.0

SOURCE: Alberta Eastern Gas Limited.

CHART 4-1

THE DEMAND FOR GATHERING SYSTEM CONSTRUCTION

YEAR:	1972	1973	1974	1975	1976
GAS AND OIL WELLS COMPLETED	2006	2843	2739	3034	4185
MILES OF GATHERING SYSTEM CONSTRUCTED	2000	2000	1300	2500	3000



SOURCE: Oilweek.

NOTE: These data apply to Canada.

factor is that the location of the line may require substantial transportation charges (the hourly cost of transportation rose some 70 percent between 1973-76) and other costs due to the nature of the terrain.

However, unlike the drilling industry where different depths create another demand variable, the different size of line pipe does not constitute nearly the same influence upon demand in the gathering system business. Consequently, most of the equipment used in the line construction is able to be employed almost anywhere the job demands.

The ability to be able to use the same equipment to build gathering systems of different pipe size and location allows the contractor an added flexibility when demand fluctuates due to seasonal factors or other demand variable changes. This is an important aspect of the gathering system construction business which is further examined in the following section.

4.2.2 Equipment and Materials

The equipment and material used in this business are supplied by both the contractor and the owner. The contractor supplies most of the equipment needed to install the pipeline, while the owner supplies most of the material needed, such as pipe, coating and fittings.

The contractor usually has the option to either rent or buy the equipment needed, and his decision significantly influences the type of costs he faces. If the contractor rents most of the equipment, then the cost of equipment becomes variable with the

demand for work.

Where the contractor owns equipment, two situations may arise. If the equipment has been recently purchased, then its costs becomes fixed over the payment period, and this adds to the overhead of the contractor. However, if the equipment owned by the contractor is old enough to have been paid for, but is still in good working order, then the cost at which the equipment is charged out will be discretionary, especially if the contractor plans to rent replacement equipment when the owned equipment ceases to be useful.

It is the ability to rent much of the equipment needed which adds a dimension to the costs of the construction contractor not available to the drilling contractor. Even though rents have increased between 20 and 120 percent over the review period, the variable cost of rental equipment is an important feature, especially when the costs of new equipment (and equipment overheads) have risen between 40 and 50 percent from 1973-76, as shown in Table 4.2.

It should be noted here that there were some improved equipment efficiencies due to equipment being sized and powered to better meet specialized construction situations. This was particularly true in the low pressure gas gathering systems, and while these improvements can be recognized, they are difficult to quantify.

With respect to the cost experience of the materials required for gathering system construction, the cost of steel played

TABLE 4.2

PRICE INDEX OF CONSTRUCTION MACHINERY AND EQUIPMENT

YEAR:	1971	1972	1973	1974	1975	1976
CANADIAN MADE	95.5	98.1	100.0	111.6	133.1	141.9
IMPORTED	93.8	95.6	100.0	113.9	143.1	147.2
COMPOSITE	94.3	96.4	100.0	113.1	140.0	145.5

SOURCE: Statistics Canada

a very important role because so much of the material is steel. Pipe is the principal material cost and it rose by some 57 percent at the mill during the review period. However, to get the pipe to Edmonton or Calgary usually required transportation charges to be added. As a result, the cost of pipe delivered to the owner's yard rose some 70 percent over the 1973-76 period. In addition, the cost of coating the pipe rose by 25 percent and the cost of fittings for the line rose 50 percent for gaskets and over 200 percent for weld caps. However, these latter two items have a 1976 unit cost of less than $50. and the increases while great, are not substantial in view of the total 1976 construction cost over $17,000. per mile for a 2½ inch diameter gathering system.

While the cost increases in the equipment and material used to construct gathering systems was significant over the review period, there were some improved efficiencies which moderated some of the cost increases. One of these was a continuation of the trend towards shop fabrication of many assemblies which are then shipped to the field to be installed. Another was the continued use of good planning to gain the benefits of economics of scale in the construction process. This planning allowed more miles of gathering system to be constructed under one contract and reduced the cost of having equipment, materials and personnel assembled and transported.

Another cost reduction due to innovations came from the expanded use of a cold-joining process for pipe connections[1]. To date, this process has been used primarily in the low pressure gas region of Southeastern Alberta where the gas does not contain H_2S. However, continued testing is being done both in terms of the size of pipe which is used (machines to handle 12" pipe were introduced in 1976), and in the pressure and composition of the gas.

The chief benefits of using the cold-joining process are the reduced labor costs, and the increased speed of joining. The labor costs are reduced primarily because welders are replaced by less skilled personnel. This substitution of labor skills itself can reduce the contractor portion of the construction costs by 10 percent.

In addition, where the terrain is suitable, the cold-joining process increases the speed of joining the pipe and therefore reduces costs. However, when the terrain becomes more difficult, this cost reducing effect may be lessened due to the pipe being in awkward positions such as steep side hills.

Finally, the amount of cost reductions due to the Zap-Lok process have been somewhat tempered by the fact that it is presently the only commercial cold-joining process available. Consequently,

---

[1] This process is currently marketed in the oil patch by Zapata Pipeline Technology, Inc., and it has the trade name of "Zap-Lok Joint". The process uses a grooved end of one joint of pipe to fit inside the expanded end of another, and then, using epoxy and high pressure, the ends are sealed together.

it is priced on an opportunity cost basis; that is, its price is set in relation to the next most economical alternative, and not necessarily by the cost of providing the service.

4.2.3 The Construction Contractor

The number of new entrants into the gathering system construction business increased significantly over the 10 year period prior to 1976. This resulted in an increase in competition which has reduced the profit margins of the contractors to levels below those which prevailed before the new firms entered.

There are two basic reasons for the ease of entry, and they characterize the gathering system construction business. First, as has been discussed previously, the ability to obtain a large amount of equipment through renting has resulted in much of the cost of equipment being variable. Further, it also means that a new entrant does not need a large investment in equipment to be competitive.

Second, the need for a relatively small construction crew who are mostly low-skilled and temporarily employed also allows the manpower costs to be variable. The size of the crew and its transitory nature have also led to a non-union work force, even though some of the skilled workers may be union members. Unlike the drilling industry where demand for improved labor skills will cause a move toward a more stable labor force, the gathering system construction business does not appear to require increased skills from its manpower.

In turning to the cost experience of the construction contractor, it basically followed the costs of the two major inputs – labor and equipment. The labor costs increased in line with the low-skilled nature of the industrial composite labor increase of some 60 percent due to the low-skilled nature of the manpower. As has been discussed, the cost of equipment to the contractor could be either fixed or variable, but the cost increases averaged about 50 to 70 percent over the review period.

Consequently, the portion of the costs of gathering line construction made up by contractor expense remained basically unchanged over the 1973-76 period, running between 23 and 26 percent.

4.2.4 The Owner

The actions of the owner of the gathering system have tended to moderate the trend of cost increases in gathering system construction. This is principally due to better planning of the construction process.

The owner is usually the party responsible for getting the necessary permits, material and contractors together at the same time and place to effect a smooth construction pattern. Continued improvements in the planning of this part of the construction process have in themselves helped to reduce costs. Also, there was a trend over the review period toward constructing larger gathering systems under one contract because the owners could realize cost savings from not having the extra charges for transporting equipment and assembling materials and personnel that are involved when several contracts are let at different times.

While it is not possible to quantify the significance of these cost improvements, they are generally recognized to have had an appreciable effect, particularly when the improved planning has been combined with larger construction projects.

4.2.5 Government

New regulations respecting the issuance of pipeline construction permits were established in 1976, and difficulties due to incomplete applications as well as what appears to be slow processing of the applications have resulted in delays which increased costs.

Also, regulations which deal with the environmental, and especially archeological factors have been introduced, and these have caused route changes as well as delays in construction which increase costs. However, both the permit bottleneck and environmental situation tend to be case specific in terms of the costs which they incur, and quantification on an overall basis is not reasonable.

Finally, it should be noted that disputes between levels of governments over price of production and disposition of revenues during the review period did not have the same effects upon the gathering system construction business as upon the drilling industry. The chief reason for this is found in the fact that much of the equipment in the former is either rented, thus reducing overheads, or because much of the equipment which may be owned is either paid for or is useful in other construction contracting sectors.

4.3 Factors in the Future Behaviour of Costs

The chief factor which will influence future cost increases in the gathering system construction business is the effects of general economic activity within Canada and the remainder of the industrialized world upon the cost of equipment, material and labor.

Due to the nature of the supply of these major cost items, as well as the availability of many competitive contractors, the rate of future cost increases will be on the same order as the general rate of inflation in Canada. Specifically, the ability of foreign and domestic suppliers to compete in steel pipe and equipment will combine with the need to have skilled labor only at the top level of contractor operations to maintain reasonable cost increases.

Clearly then, the economic activity within Canada, as influenced by business cycles and government economic policy will directly bear upon costs in this construction business. As well, the advent of a new concurrent economic boom amongst the world's industrialized nations would result in cost increases throughout the economy as well as in the gathering system construction business.

Aside from the large availability of supply of equipment, materials and labor, there will be cost reducing improvements in the expanded use of the cold-joining process and improved planning. Further, the difficulties which have attended pipeline permit approval and new environment regulations will be reduced, resulting

in cost efficiencies. However, these will tend to be offset by the new vehicle road weight regulations in Alberta which will raise the cost of transportation of equipment and materials.

APPENDICES

APPENDIX A

TABLE A.1

BREAKDOWN OF BUREAU OF LABOR STATISTICS (BLS)
22 COMMODITY PRICE INDEX

Year	22 BLS Index	Food Stuff 9 Items	Raw Industry Commodity 13 Items	Livestock And Produce 5 Items	Metals 5 Items	Textiles And Fibres 4 Items	Fats And Oils 4 Items
1970	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1971	95.2	99.1	92.7	94.3	82.3	98.0	98.1
1972	105.2	101.0	108.4	116.4	91.8	122.8	89.3
1973	150.8	153.9	148.8	180.1	116.3	159.2	146.1
1974	195.0	188.5	199.7	153.8	208.8	184.1	174.4
1975	167.2	191.9	152.2	194.8	133.2	159.0	166.1
1976	185.7	190.5	182.6	181.6	172.0	181.6	162.0

TABLE A.2

OIL SERVICE AND SUPPLY INDUSTRY

The return on equity of this group, as found by using data from Business Week, is compared to the United States industrial average for 1973 through 1976. As well, the concentration ratio of the four largest firms in sales and profits is shown for 1973 and 1976

	1973	1974	1975	1976
Return on equity (%):[a]				
U.S. Oil Service and Supply	13.6	18.0	21.8	24.0
U.S. Industrial Composite	14.0	14.0	11.8	14.0
CR 4:(%) Sales[b]	71.3			75.8
Profits	68.6			80.9

[a]Return on Equity = net available for common shareholders divided by total of common stock, capital surplus and retained earnings.

[b]CR4: the ratio of the sales or profits of the four largest firms to the industry totals.

APPENDIX B

Offshore Drilling Rigs

The offshore drilling rig comes in five basic configurations as defined by the structure used to carry the drilling derrick, equipment and material. The five types of structures are drillship, drillbarge, jack-up, semi-submersible and submersibles. The latter are not in much use, and none have been constructed over the review period.

The demand for offshore rigs is a function of the price of crude oil and natural gas as well as the permit and environmental regulations which exist, or do not exist, in the prospective areas. Furthermore, the demand for offshore rigs is not only categorized by the depth capacity of the drilling rig itself, but also by the depth of water in which the structure can operate. As with land based drilling, the categorization of rigs by depth can lead to some types of offshore drilling rigs having slack demand while others have excess demand.

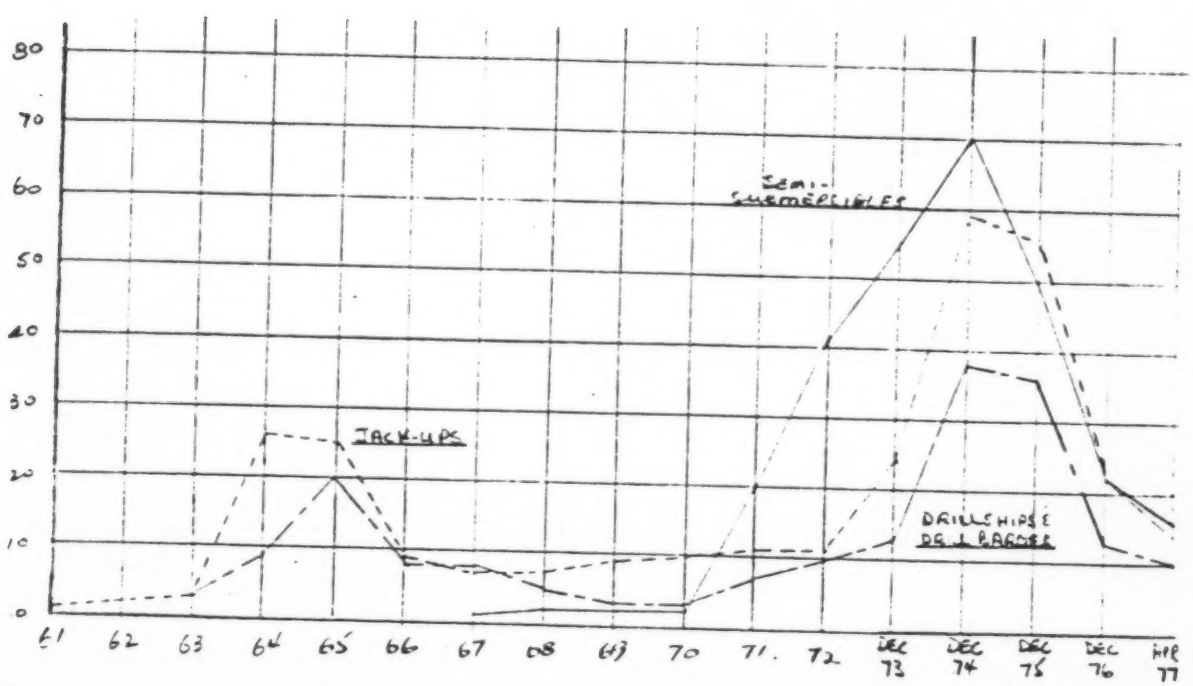
Since 1959, the demand for offshore rigs as measured by active rigs, has steadily increased except for a small, short-lived decline in 1967. However, the supply of new rigs fluctuated significantly between 1959 and 1970, after which there was a substantial rise in the number of rigs under construction, led by the construction of semi-submersibles, as shown in Chart B-1.

CHART B-1

OFFSHORE RIGS UNDER CONSTRUCTION

YEAR	SEMI SUBMERSIBLES	JACK-UPS	DRILLSHIPS & DRILLBARGES	TOTAL
1959	--	3	2	5
1960	--	2	2	4
1961	--	1	1	2
1962	--	2	2	4
1963	--	3	3	6
1964	--	26	9	35
1965	--	25	20	45
1966	--	9	8	17
1967	1	7	8	16
1968	2	7	5	14
1969	2	9	3	14
1970	2	10	3	15
1971	20	11	7	38
1972	41	11	10	62
DEC., 1973	55	24	13	92
DEC., 1974	70	59	38	167
DEC., 1975	49	55	36	140
DEC., 1976	22	22	13	57
APR., 1977	16	14	10	40

SOURCE: Offshore Magazine.



This demand for rigs, when combined with the general economic conditions and the improved capabilities built into the rigs, led to very significant cost increases for offshore rigs. This is evident from Chart B-2 which illustrates not only the absolute cost increases, but also the wide variance in costs due to the differences in water and drilling depth capacities of the offshore rigs.

While there is little doubt that the demand for offshore rigs will continue to grow as new sources of hydrocarbon energy are sought, the surge in demand for rigs, and consequently the surge in construction is not likely. Certainly, there will be fluctuations in the construction of offshore rigs, but the crude oil price movements which caused so many new regions to become economically viable, and which added a new urgency to the development of new reserves are not likely to be repeated. More orderly, and anticipated, price increases in hydrocarbon products are the probable course of future events, and such pricing will allow planning of supply requirements for new exploration programs to be effective.

In conclusion, the construction and equipping demands of offshore rigs put a severe burden upon the capacity to supply drilling equipment. This situation eased during 1976, and, while there will be fluctuations in the supply and demand of new offshore rigs, there will not be a severe supply constraint which would unduly affect prices in the medium term future.

CHART B-2

CAPITAL COST OF OFFSHORE RIGS

	CAPITAL COST ($ MILLIONS)			
DELIVERY DATE	DRILLSHIP (MOORED)	DRILLSHIP (DYNAMIC POSITIONING)	JACK-UP	SEMI SUBMERSIBLE
1971	8-9	17-19	8-10	20-21
1972	9-11	20-23	10-12	23-24
1973	11-13	23-25	12-16	25-27
1974	15-16	34-35	16-20	35-40
SEPT., 1975	20-35	35-55	25-35	40-60
FEB., 1977	30-35	35-80	19-38	31-62

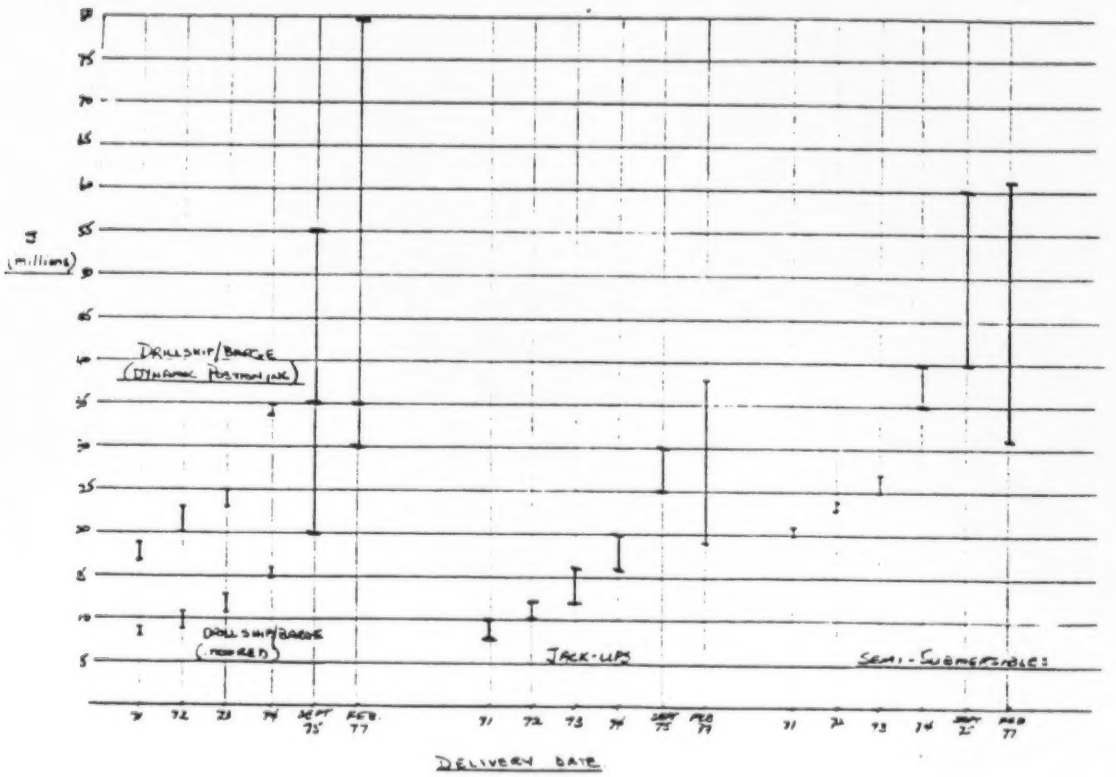
COST VARIATION FOR DRILLSHIP/BARGE

WATER DEPTH (FT.)	DRILLING DEPTH (FT.)	POSITIONING TYPE[a]	CAPITAL COST ($ MILLION)	COMPLETION DATE
2,000	25,000	DP & WW	35	5/77
2,000	25,000	DP & WW	36	1/78
3,300	20,000	DP	80	77
2,000	25,000	DP	40	3/77
600	25,000	ANCHORS	--	1/77
3,000	20,000	DP	60	12/77
1,500	20,000	ANCHORS	35	77-78
1,000+	25,000	ANCHORS	30	5/77
2,000	20,000	DP	46	9/77
2,000	20,000	DP	52	4/77

SOURCE: Ocean Industry (Sept., 1975; Feb., 1977).

[a]DP = Dynamic Positioning; WW = Wireless Winches

CHART B-2 - CONTINUED



APPENDIX C

The Canadian Drill Bit Industry

In 1962, Western Rock Bit Company Limited (WRB) was formed in Canada. This company assembles and markets Hughes drill bits, a pioneer drill bit company with sales throughout the world. Drill bits can constitute some 2 to 3 percent of the cost of drilling a typical well south of 60^{o} N.

The shareholders of WRB are, principally, various drilling contractors in Canada. Indeed, in April of 1977, some 77 percent of the rigs located in Western Canada were owned by contractors who are shareholders of WRB.

Where the drilling contractor has a day-work contract, the choice of the bit is usually made by the operator, and where the drilling contract is based upon footage, the contractor usually has the choice of bit.

As a result, there is an economic advantage not necessarily based upon performance which enters into the decision of a WRB contractor when the choice of bits is made by that contractor. This can result in inefficiencies through two means: first, the natural course of events under the prevailing circumstances may not leave enough demand, after the 'locked-in' sales of WRB, to allow sufficient market for the other three main bit suppliers to exist. Hence, competition is reduced.

Second, if there is a defect in the WRB bits, the added economic advantage to the WRB contractor may be enough to cause him to use a bit which is not best suited to the job. This may well result in cost inefficiencies which could raise the overall cost of drilling to the operator.

For the purposes of the costs found in the 1973-76 period, the latter of those inefficiencies does not appear to have existed. The former inefficiency did exist, but it had done so for a time well before 1973. Therefore, any costs due to reduced competition would have already been introduced, and were only maintained during the review period.

APPENDIX D

The Canadian Drilling Contractor Industry

The structure and behaviour of an industry can significantly influence its performance, and for this reason, a brief description of the Canadian drilling contractor industry is warranted.

The Canadian Association of Oilwell Drilling Contractors (CAODC) was established well before the 1973-76 review period. The CAODC provides its members with relevant information with respect to drilling activity, rig locations, and new regulatory standards, and it also co-ordinates activities such as the introduction of metric units into the industry. These are normal and typical activities which industry associations like the CAODC are expected to co-ordinate.

However, several activities of the CAODC go beyond the co-ordination of information as described above. To be specific, there are several activities which are pertinent:

1. The determination of basic wage rates in the drilling industry is done through the CAODC. Certainly, member firms are not bound by these rates, but there is concerted effort by the CAODC to have uniform wage rates throughout the industry.

2. The publication of future recommended daily work rates by the CAODC constituted activities beyond the co-ordination of

past or present information. Again, member firms are not required to follow these rates, but the efforts of the CAODC and its members to publish such rates requires a pooling of firm information which can tend to reduce competition.

3. The publication of standard terms of contract and future rates applicable to support equipment and crew transportation charges again implies a role for the CAODC beyond information co-ordination.

The CAODC, then, serves to create an environment within which the industry interests are enhanced or protected. Once this has been accomplished, the individual member firms are free to bid 'competitively' for work.

This structure existed prior to 1973, and therefore is not likely to have significantly affected cost increases during the review period because its affect upon costs would have occurred earlier. Indeed, the October 1, 1976 annual cost and rate book published by the CAODC reflects the legislative changes in the Competition Act (Bill C-2) by dropping the future recommended daily work rates and many of the support, transportation and standard contract clauses. These have been replaced by cost formulae and historical data.

This latest change may well serve to increase competition amongst the CAODC members, but it will remain to future examination to determine how much the increased competition will affect costs.